OPERATIVE SURGERY

OF THE

NOSE, THROAT, AND EAR

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OF THE

NOSE, THROAT, AND EAR

FOR LARYNGOLOGISTS, RHINOLOGISTS, OTOLOGISTS, AND SURGEONS

BY

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PREFACE.

This work was undertaken at the suggestion of many colleagues, with no little misgiving on the part of the author. To lighten the burden and to make the publication more effective, it was divided among collaborators who were specially qualified for the assigned topics.

The endeavor has been to present the operative surgery of the nose, throat and ear, unaccompanied by any discussion of pathology, etiology or symptomatology. The method of operating, the indications, the contraindications, after-treatment and results have been considered paramount for the purposes of this work.

The illustrations are practically all original, the majority of them being drawn expressly for this work. They are planned to make the text clear without too great a sacrifice of detail.

The first volume deals with the more general subjects, such as the surgical anatomy of the nose, throat and ear, the external surgery of the throat, the direct examination of the larynx, trachea, bronchi, esophagus and stomach, and the operations made possible through its agency, and the plastic surgery of the nose and ear.

Volume II is to be devoted to the more specialized surgery of the nasal cavities, the pharynx and larynx, which has been developed during the years of laryngologic and otologic activity, since the laryngoscope was devised.

Grateful acknowledgment is here made to the many who have by their efforts, advice and encouragement rendered this publication possible, to Mr. A. Schwitalla, S. J., who was of great assistance in reviewing the text, to the collaborators, and to the publishers, whose patience has been most commendable.

H. W. L.

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VOL. I.

OPERATIVE SURGERY OF THE NOSE, THROAT, AND EAR.

CHAPTER I.

THE SURGICAL ANATOMY OF THE NOSE.*

BY HANAU W. LOEB, M.D.

External Nose.

The external nose (nasus) which projects downward and forward from the forehead, between the eyes, presents two lateral and one inferior surface, all triangular in shape, and a superior surface which varies considerably in size and contour. As seen in Figs. 1 and 2 the root of the nose (radix nasi) is that portion projecting for a short distance downward from the forehead, and the bridge of the nose (dorsum nasi) is the superior surface extending from the root to the tip of the nose (apex nasi).

The supporting framework of the nose is composed of bones and cartilages, united by connective tissues. It is lined with mucous membrane and covered by muscles and integument.

The nasal bones and the frontal processes (processus frontales maxillæ) of the maxillæ which constitute the bony framework of the external nose are attached by strong connective tissue fibers to the lateral cartilages (cartilagines nasi laterales) at the apertura piriformis (Figs. 1, 2, 9 and 11). Each of these cartilages is triangular in shape with the apex downward, and is attached to the cartilage of the septum (cartilago septi nasi), and to its fellow on the oppo-

*For the convenience of readers, structures are designated by their usual English names. However, the B.N.A. nomenclature is given in the text and exclusively in the figures in order to follow recognized authority in terminology.

The figures accompanying this chapter have been made from drawings of Mr. Tom Jones, with the exception of Figs. 20 to 34, inclusive. Acknowledgment is gratefully made to Dr. D. M. Schoemaker for the dissections illustrated by Figs. 1, 2 and 3. The remaining preparations, except those illustrated by Figs. 9, 11 and 12, were made by the author.

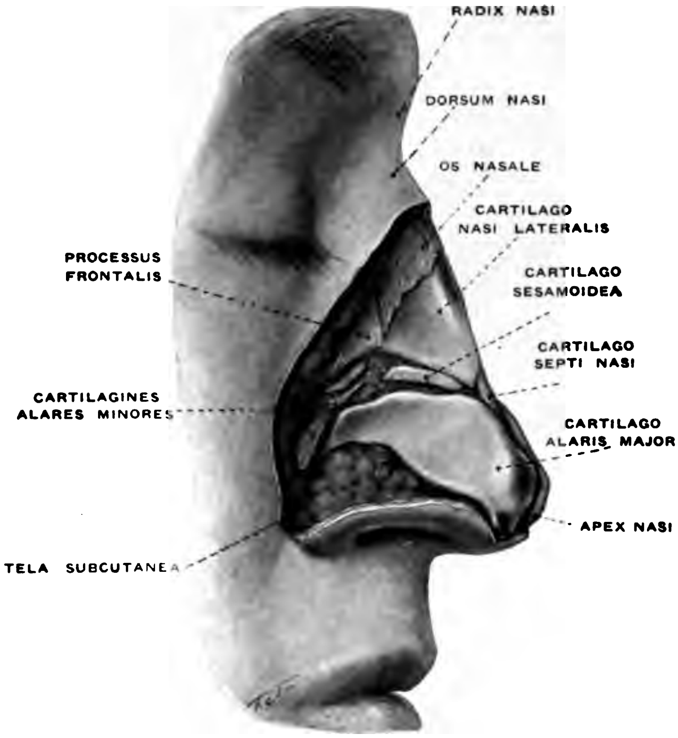


Fig. 1.
The cartilages of the nose; lateral view.

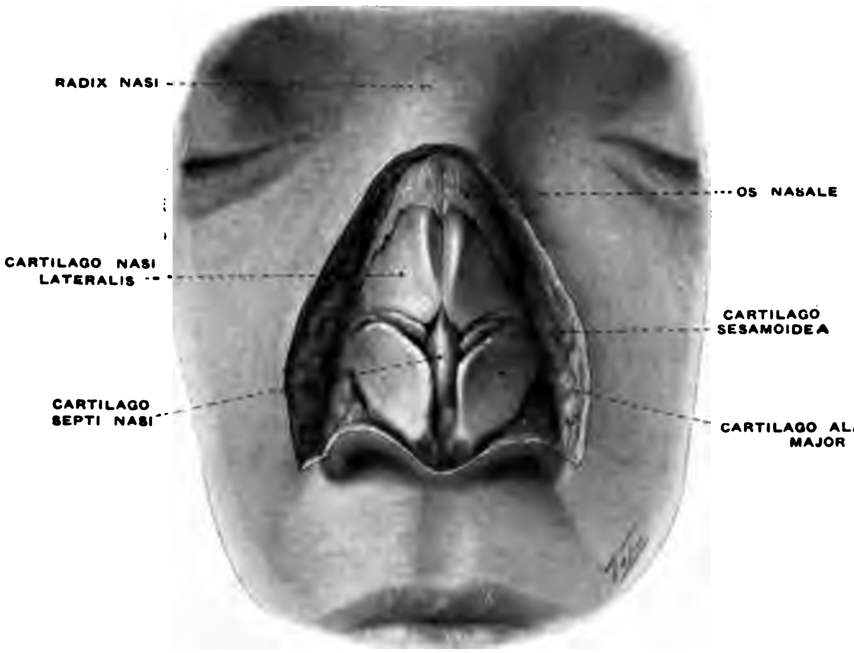


Fig. 2.
The cartilages of the nose; anterior view.

site side. A variable number of sesamoid cartilages (cartilagines sesamoideæ) are found between the lateral nasal cartilage and the greater alar cartilage (cartilago alaris major). The lesser alar cartilages (cartilagines alares minores) are small cartilaginous plates, variable in number, which lie between the greater alar cartilage and the maxilla.

The greater alar cartilage (cartilago alaris major), very variable in shape and extent, constitutes in large measure the framework of the lower lateral portion of the external nose, and that of the ala (crus laterale). The medial portion (crus mediale) (Fig. 3) winds around the anterior inferior portion giving to the naris its rounded appearance. It is loosely connected with the cartilage of the septum. A mass of connective tissues lies behind and below the greater alar cartilage forming a considerable portion of the ala (tela subcutanea).

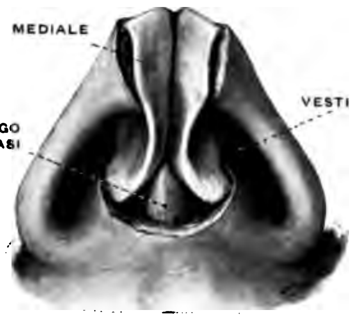


Fig. 3.

The orifices of the nose showing a dissection of the crura medialia of the cartilagines alares majores.

Nasal Cavities.

The anterior portion of the nasal cavities, between the ala and the septum, is called the vestibule (Figs. 3, 6 and 7). It is covered with squamous epithelium and contains numerous stiff hairs known as vibrissæ.

The nasal cavities, right and left, are hollow spaces between the bones of the head and face, extending backward from the vestibule to the nasopharynx, and from the floor of the cranial cavity above to the roof of the mouth below.

Floor of the Nose.—The bony floor, narrowest at its anterior extremity, becoming wider posteriorly and then narrower at the choanæ, is formed by the palatal process of the maxilla (processus palatinus ossis maxillaris) and the palatal process of the palate bone (processus horizontalis ossis palatini). The suture between these bones divides the floor into two unequal portions, the anterior three-fourths approximately being maxilla and the posterior one-fourth

palate bone. (Fig. 4.) The canalis incisivus which opens on the septum just above, penetrates the floor in its anterior portion conveying the nasopalatine nerve and artery to the roof of the mouth. The sinus maxillaris may be seen external to the lateral wall of the nose extending below the level of the floor. (See also Fig. 13.)

Septum Nasi.—The septum nasi forms the inner wall of each nasal cavity, approximately in the median line. It may be straight, but more often it is bent to one side or the other or irregularly deviated in one or both nares. It is divided into three parts, the bony (septum nasi osseum), cartilaginous (cartilagineum) and membranous (mem-

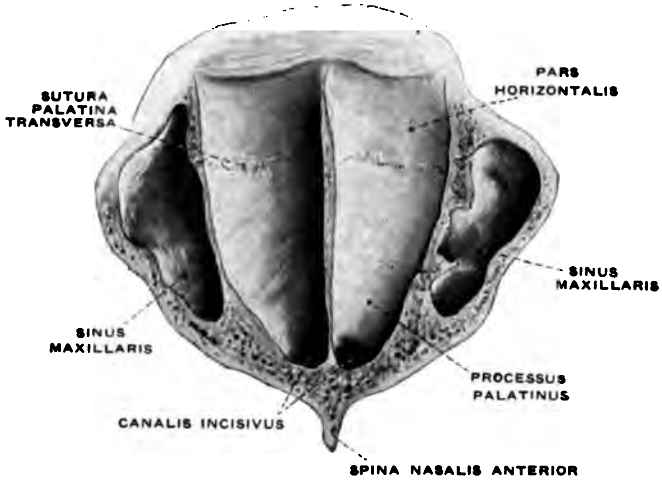


Fig. 4.
Floor of the nose.

branaceum) septum (Fig. 5). The membranous portion (septum mobile nasi) separates the vestibule from its fellow, and is made up of the crura medialia of the two greater alar cartilages, with their attachments to the septum nasi, covered by a mucocutaneous investment. The cartilaginous portion (septum cartilagineum) is formed by the cartilage of the septum and the cartilage of Jacobson. The cartilage of the septum is more or less quadrilateral in form and is attached posterosuperiorly to the perpendicular plate of the ethmoid (lamina perpendicularis ossis ethmoidalis), posteroinferiorly to the groove of the vomer, inferiorly to the anterior part of the crista nasalis maxillæ and to Jacobson's cartilage, and superiorly to the nasal bones and the lateral cartilages. From the posterior angle a projection extends backward often for some distance, known as the processus sphenoidalis septi cartilaginei. Jacobson's cartilage (cartilage vomeronasalis

Jacobsoni) lies between the cartilage and the vomer, and the nasal crest of the maxilla.

The bony portion is composed of the perpendicular plate of the ethmoid, the rostrum of the sphenoid (crista sphenoidalis), the vomer, the maxillary crest (crista nasalis maxillæ), and the palatine crest (crista nasalis ossis palatini).

The perpendicular plate of the ethmoid extends downward and forward from the cribriform plate of the ethmoid (lamina cribrosa ossis

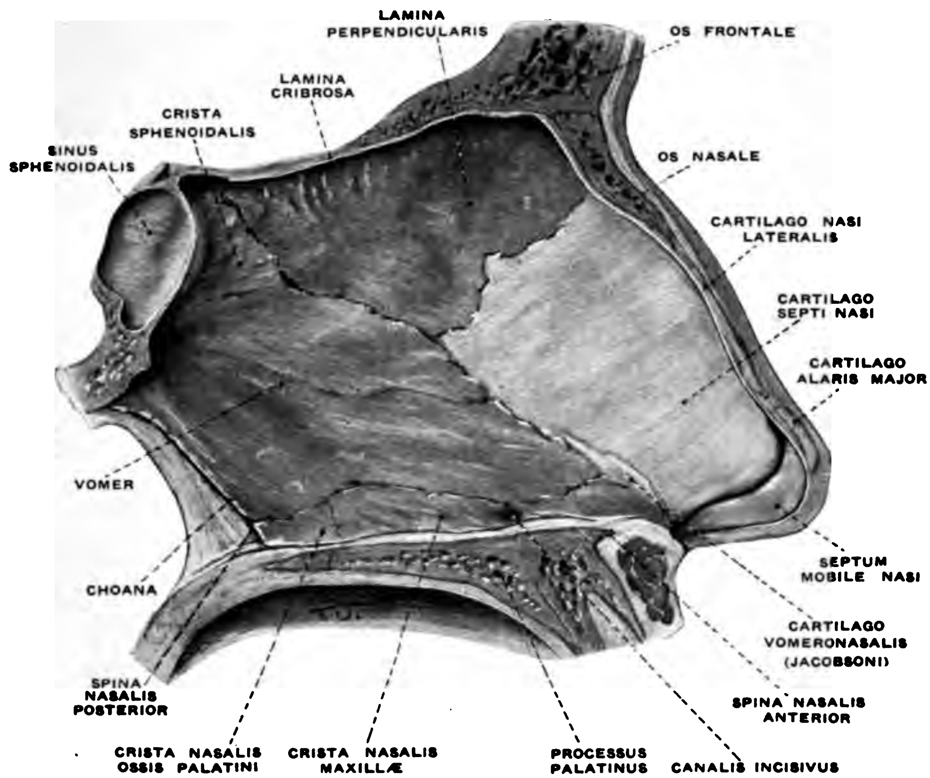


Fig. 5.
The septum nasi.

ethmoidalis) having attachments with the nasal spine (spina nasalis) of the frontal, the nasal bones, the cartilages of the septum, the vomer and the rostrum of the sphenoid.

The vomer constitutes practically the whole of the posterior and inferior part of the septum, articulating below with the nasal crest of the maxillary and palate bones, anteriorly and superiorly with the cartilage of the septum, Jacobson's cartilage and the perpendicular plate of the ethmoid, and superiorly with the rostrum and body of the

sphenoid. Its superior margin divides into two wings, alæ vomeris, by which it is attached to the sphenoid. The posterior border forms the dividing boundary of the two choanæ or posterior nares. (Fig. 8.)

The rostrum of the sphenoid takes part in the formation of the

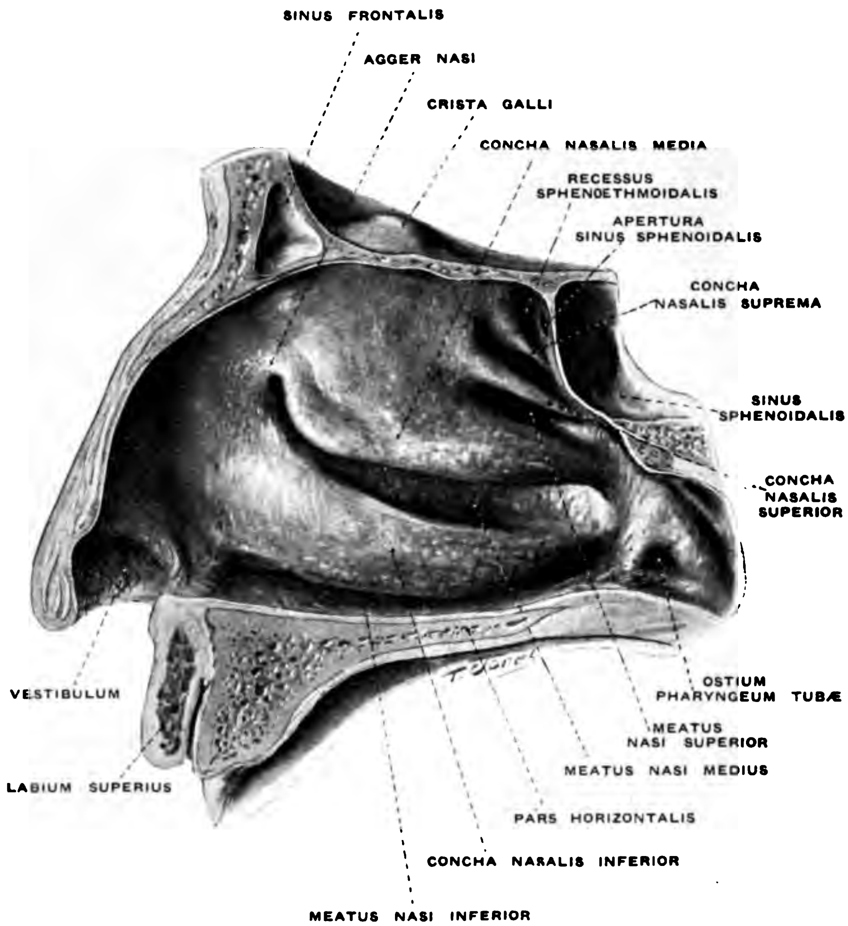


Fig. 6.

The outer wall of the right nasal cavity.

septum. In the specimen illustrated (Fig. 5) it is triangular and considerably larger than usual.

The maxilla furnishes but a small part of the nasal septum, the crista nasalis, which by its articulation with the vomer, Jacobson's cartilage, and the cartilage of the septum, comprises the inferior portion of the septum, corresponding to the extent of the maxillary portion of the floor. In its anterior half it presents the canalis incisivus for the passage of the nasopalatine nerve and artery. Its most anterior pro-

jection is the anterior nasal spine (spina nasalis anterior). (Figs. 4 and 5.)

Corresponding with the nasal crest of the maxillary is a similar projection upward from the horizontal plate of the palate bone. It lies behind the nasal crest of the maxillary and articulates with it at the sutura palatina transversa. Posteriorly it presents the posterior spine (spina nasalis posterior).

Roof of the Nose.—The roof of the nose is constituted from before backward by the following bones: the nasal, the frontal, the ethmoid and sphenoid. The lamina cribrosa of the ethmoid (Figs. 5, 12, 45, 46, 48, 50, 53, 54 and 55) which conveys the filaments of the olfactory nerve (Figs. 44 and 47) from the cranial cavity into the nasal cavity is almost horizontal. It is composed of very hard bone which is easily recognized by the operator on account of its resistance to the instrument. The sphenoid ordinarily constitutes but a small part of the roof of the nose just behind the ethmoid, likewise the frontal which lies just anterior to the ethmoid. Anterior to the sphenoid in the angle between it and the ethmoid, there is a space called the recessus sphenoethmoidalis, which receives the opening of the sphenoid sinus.

A probe with its end tipped slightly downward will readily enter the sphenoid if it is passed backward about 7 cm. along the roof to the recessus sphenoethmoidalis. As a rule to accomplish this, it is necessary to resect the middle turbinate. Figs. 6 and 7 show very clearly the possibility of using this method.

External Wall of the Nose.—The maxilla and palate which are united vertically, with their attachments, the inferior turbinate (concha nasalis inferior), lacrimal, ethmoid and sphenoid, constitute the outer wall of the nose. The inferior turbinate and the middle turbinate (concha nasalis media) (Figs. 6, 7, 15, 16, 17 and 18) are attached to the crista conchalis and crista turbinalis of the maxilla and of the palate bone. The superior turbinate (concha nasalis superior) and supreme turbinate (concha nasalis suprema), which is present in about one-third of the cases, run parallel to the middle turbinate, but are continuous with the lateral mass of the ethmoid from which they project backward for a short distance. The inferior turbinate and middle turbinate extend about the same distances forward, constituting by far the greater portion of the projection from the external wall. A line drawn along the superior border of the middle turbinate and extended to the anterior wall divides the nose into two unequal parts, a superior comprising about one-fifth and an inferior about four-fifths. The superior and supreme turbinates are much smaller and shorter than the other turbinates. They spring from

the lateral mass of the ethmoid in the posterior third of the nasal wall. However, all of the turbinates extend about the same distance backward. The choanæ therefore are in relation with the posterior ends of the inferior and middle turbinates. (See Fig. 8.) The superior and supreme turbinate lie just above the superior choanal level. Upon examination through the anterior nares, the inferior is visible for from one-half to its whole length, the middle ordinarily at its anterior end,

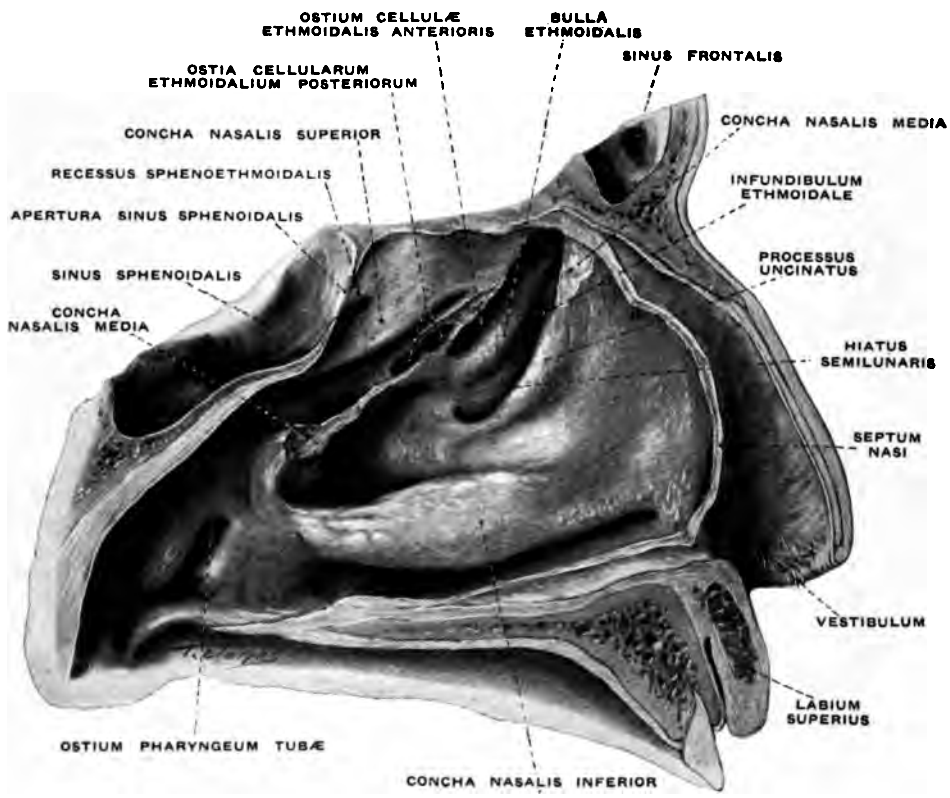


Fig. 7.
The outer wall of the left nasal cavity with the concha media removed.

and the superior and supreme are not visible unless extensive atrophy is present or unless the middle turbinate has been removed.

The inferior turbinate is attached to the lacrimal, constituting a portion of the wall of the nasolacrimal canal, and to the ethmoid; it serves to decrease the size of the orifice of the maxillary sinus.

The turbinates are covered with mucous membrane, continuous with the mucous membrane of the external wall of the nose. It is

thickest over the inferior and middle turbinates, made so by the large number of venous radicals which are present. These have been variously designated as turbinate bodies, Schwellkörper (by Zuckerkandl) (plexus cavernosi concharum); they are of great importance in the

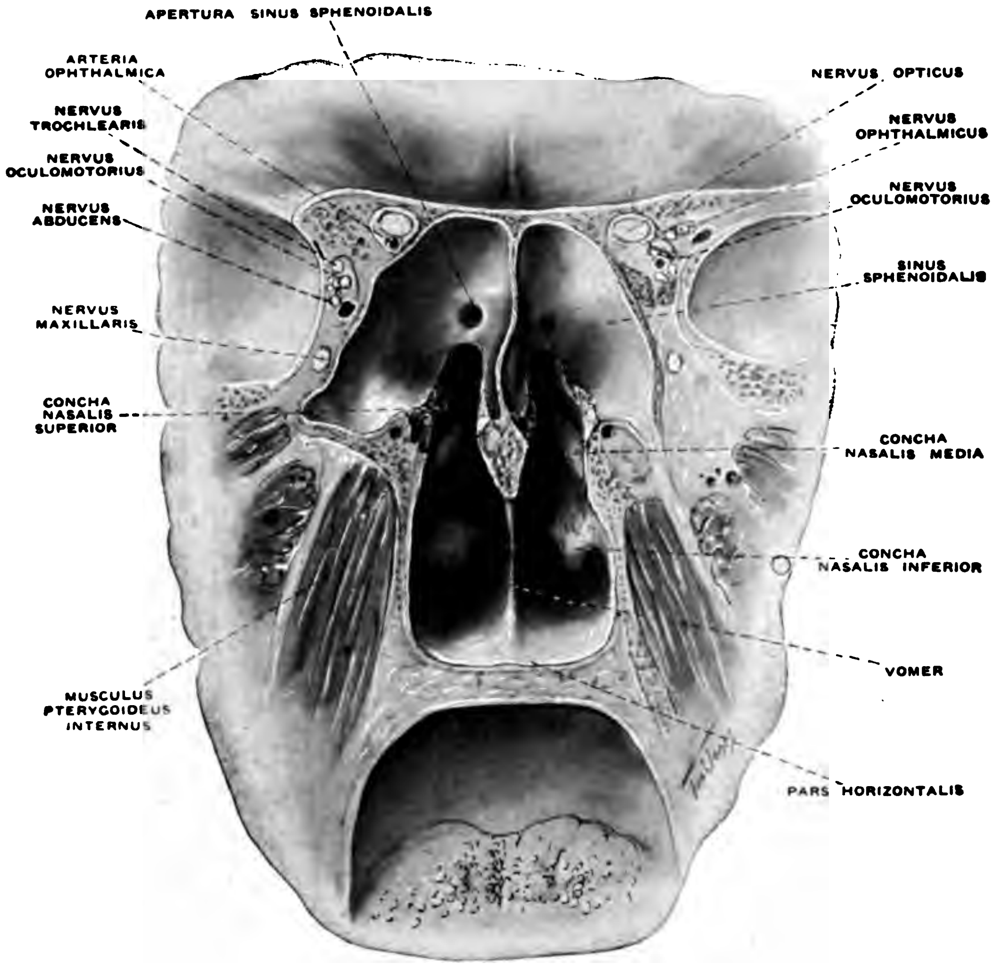


Fig. 8.
The choanæ and anterior wall of the sphenoid sinus viewed from behind.

physiologic action of the nose, more particularly in connection with respiration.

There is a small elevation on the outer wall just anterior to the middle turbinate known as the agger nasi. It is sometimes the seat of an anterior ethmoid cell. It is by entering through the outer wall at the agger nasi that Mosher recommends that the ethmoid cells be curetted without disturbing or necessarily removing the middle tur-

binate bone. Below this is a slight depression known as atrium meatus medii, which extends backward and downward into the middle meatus.

By virtue of the turbinate ledges on the external wall, the nasal cavity is divided into three meatuses, the inferior, middle and superior (Figs. 6, 13, 17 and 18).

The inferior meatus, below and lateral to the inferior turbinate bone, receives the lacrimal secretion through the orifice of the naso-lacrimal duct, in its anterosuperior portion. None of the accessory sinuses opens into it.

The middle meatus contains the orifices of the frontal and maxillary sinuses, and of the anterior ethmoid cells. These orifices in the main open into the infundibulum, a hollowed out space below the maxillary attachment of the middle turbinate and between the bulla ethmoidalis and the uncinate process of the ethmoid bone (Figs. 7 and 13). The frontal and one or more of the anterior ethmoidal cells open usually through its anterior and upper portion.

The maxillary sinus opens as a rule posterior to the orifice of the frontal sinus. It not infrequently lies in such a position that discharge from the frontal and ethmoid cells passes directly through the infundibulum into the maxillary sinus. The opening of the maxillary is not always single; one or more accessory orifices may be present, but they open into the middle meatus. The infundibulum communicates with the middle meatus through the hiatus semilunaris.

The superior meatus contains the openings of most of the posterior ethmoid cells. Occasionally one is found above the superior turbinate. Behind and above this is the opening of the sphenoid in the spheno-ethmoidal recess.

The **Choanæ** or posterior nares which are the openings of the nose into the nasopharynx are oval shaped and fairly symmetrical. They are formed by the vomer internally, the horizontal plate of the palate inferiorly, the vomer and sphenoid superiorly, and externally by the processus pterygoideus.

Fig. 8 is an illustration of the choanæ from behind with the inferior portion of the anterior wall of the sphenoid sinus cut away so as to show the nasal cavity projecting above the upper level of the choanæ. It also serves to show the relation of the sphenoid sinuses to the choanæ, the nasal cavities, and the optic nerve.

Posterior to the choanæ on each lateral wall of the pharynx is the opening of the Eustachian tube. In children the nasal cavities are relatively smaller than in adults for the reason that the turbinates are far larger in proportion.

Accessory Sinuses of the Nose.

The accessory sinuses of the nose are cavities in the maxillary, frontal, ethmoid and sphenoid bones, which are lined with a mucosa continuous with that of the nose; they communicate with the nasal cavities in places more or less definite.

In order to understand their different relations, it is advisable to study the bones which form their walls.

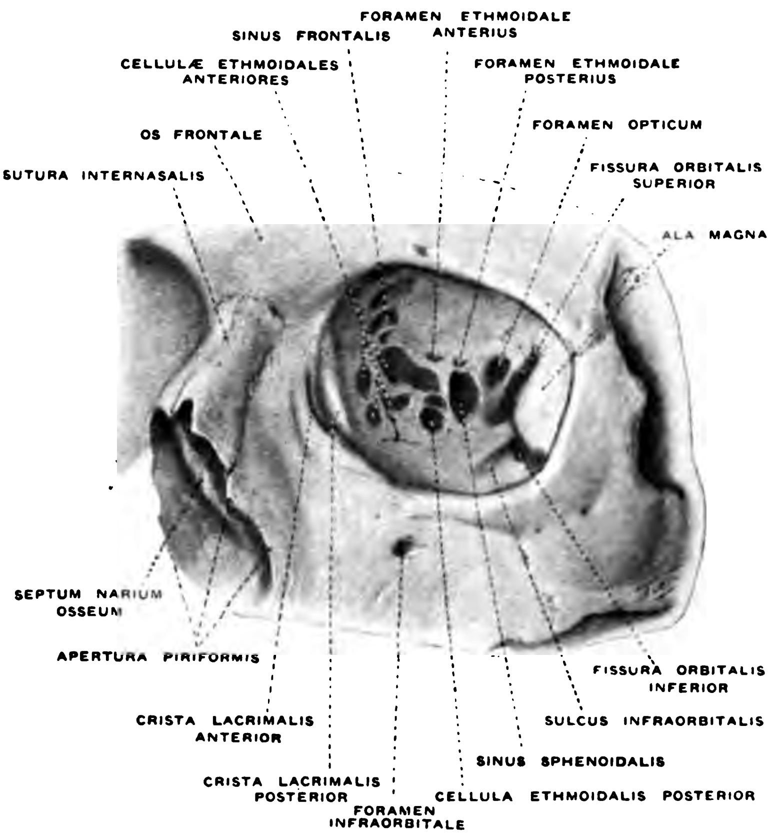


Fig. 9.

The left orbit; bone relations.

The two nasal bones united at the sutura internasalis and the two maxillary bones united at the sutura intermaxillaris, together with the corresponding nasal bones at the sutura nasomaxillaris form the apertura piriformis, or the entrance to the bony nose to which the soft parts of the external nose are attached (Figs. 9 and 11). The nasal bones above form the portion of the roof of the nose which lies anterior

to the frontal with which they articulate at the nasofrontal suture. The maxilla constitutes the anterior, external and posterior walls of the sinus maxillaris which it encloses. It articulates externally with the malar (os zygomaticum) at the sutura zygomaticomaxillaris. It is extended into the orbit and assists in forming its floor by articulating with the lacrimal, ethmoid and sphenoid bones. In the orbit, as shown

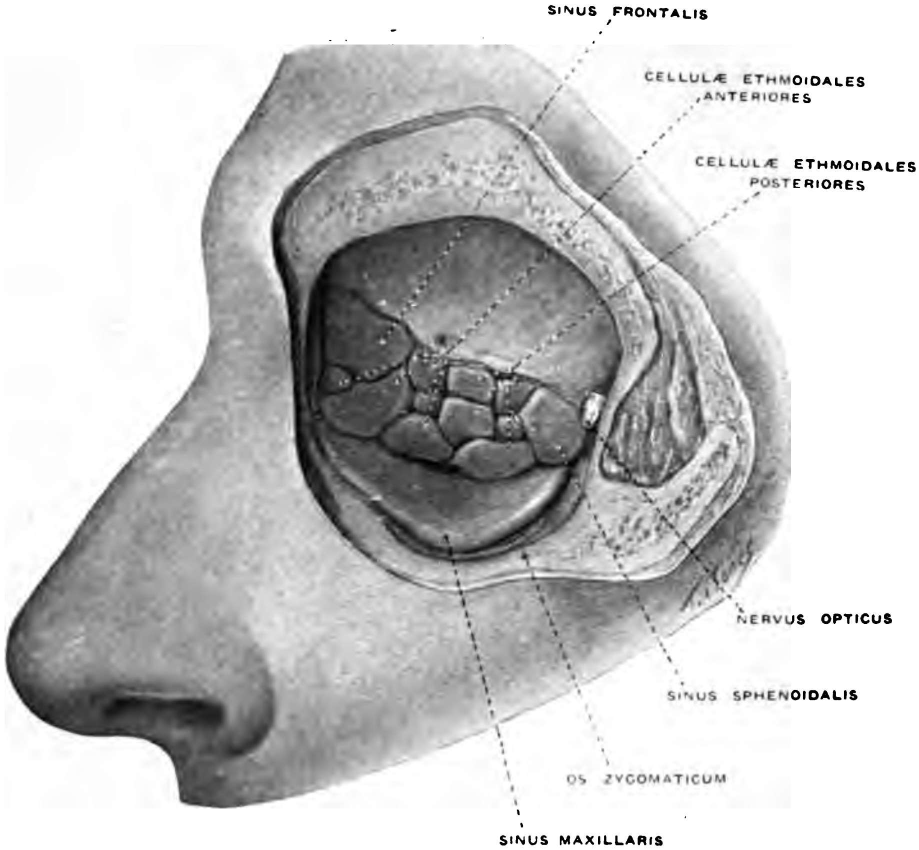


Fig. 10.
Left orbit with bone removed exposing the mucosa of the accessory sinuses.

in Fig. 9, the sinuses are visible where the bone has been cut away, the ethmoid in the lacrimal and ethmoid bones, the frontal in the frontal bone, and the sphenoid in the sphenoid bone. A realistic view of the sinuses is seen in Fig. 10, in which the decalcified bone in the specimen illustrated has been removed leaving the mucosa of the sinuses intact, the frontal, anterior and posterior ethmoid and the sphenoid, from before backward, and the maxillary below. From these

figures it is easy to observe how an inflammation of the ethmoid cells may result in a periorbital abscess.

In Fig. 11, the outer plate and cancellous tissue over the frontal sinuses have been cut away leaving the sinuses free with a thin covering of bone. The sinuses are somewhat larger than the average, but their relation to the adjacent bone structure is well shown.

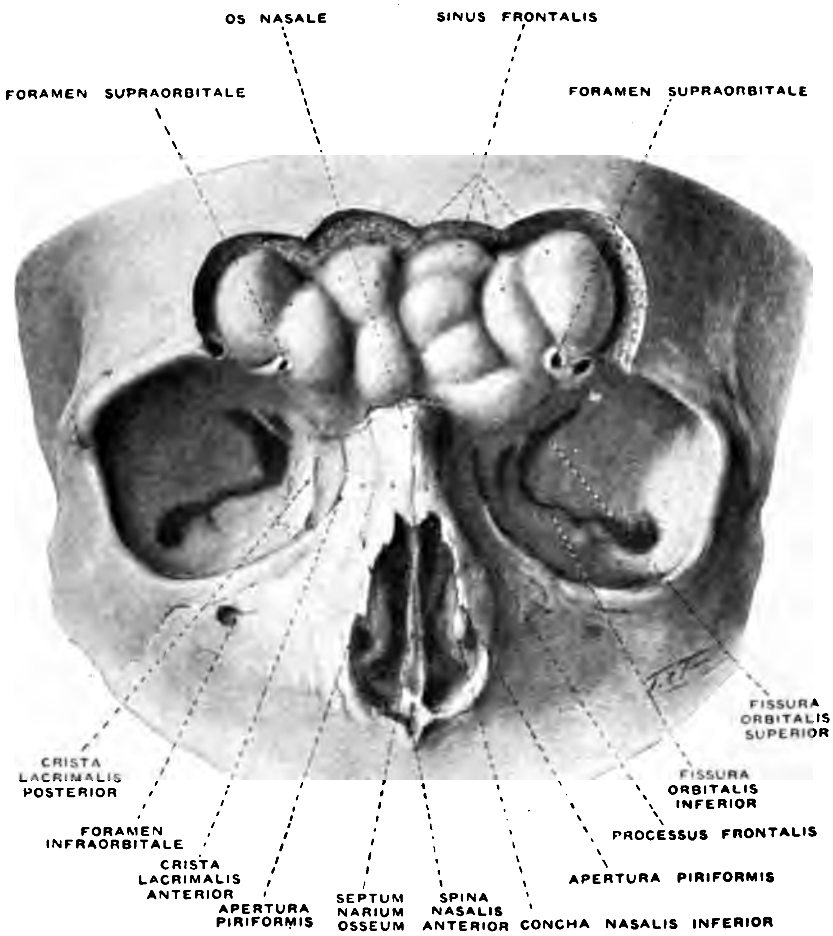


Fig. 11.

Bones of the nose and orbits; external plate over frontal sinuses removed.

The roof of the nose and of the orbits from the endocranial side is presented in Fig. 12. The relations of sinuses to the lesser wing of the sphenoid bone, the pituitary fossa (fossa hypophyseos), the optic chiasm, the frontal, and the cribriform plate of the ethmoid bone are shown. The frontal sinuses, anterior and posterior ethmoid cells and sphenoid sinuses are shown in succession.

A clearer understanding of the cells from this aspect may be secured from Fig. 52, which is made from a specimen which was prepared after decalcification by removing the endocranial bone covering from the sinuses, leaving the mucosa intact. The relation of the optic nerve to the two sphenoid sinuses and to the last posterior ethmoid cell is well brought out in this illustration.

Frontal Sinus.—The frontal sinus is the most anteriorly placed of

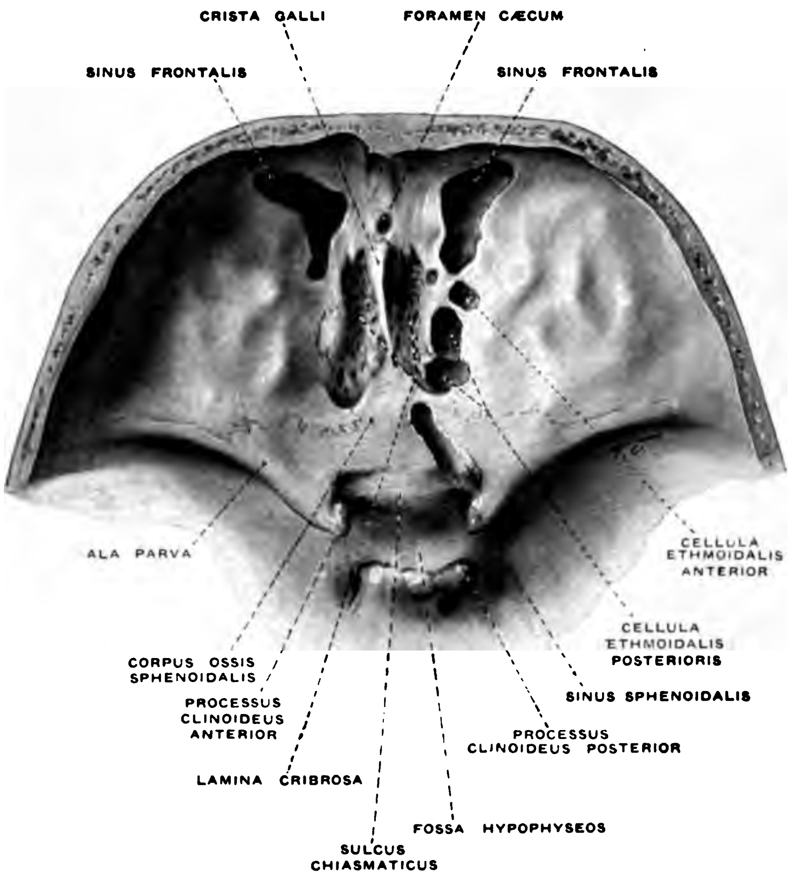


Fig. 12.

Floor of the anterior cranial fossa; bony roof of accessory sinus removed in part.

all the accessory sinuses of the nose. It varies greatly in size, but conforms in some measure to a uniform plan in that the size laterally depends upon how many recesses more or less resembling one another are present. Thus there may be one, two, three or even four of these recesses present. The frontal sinus lies between the two plates of the frontal bone. Its anterior wall forms the prominence of the forehead

above the eyebrows. (See Fig. 11.) The posterior and superior wall separates it from the frontal lobe of the brain, the inferior from the orbit. The irregularities in the anterior wall are well shown in this figure, as well as the relation to the orbit and the foramen supraor-

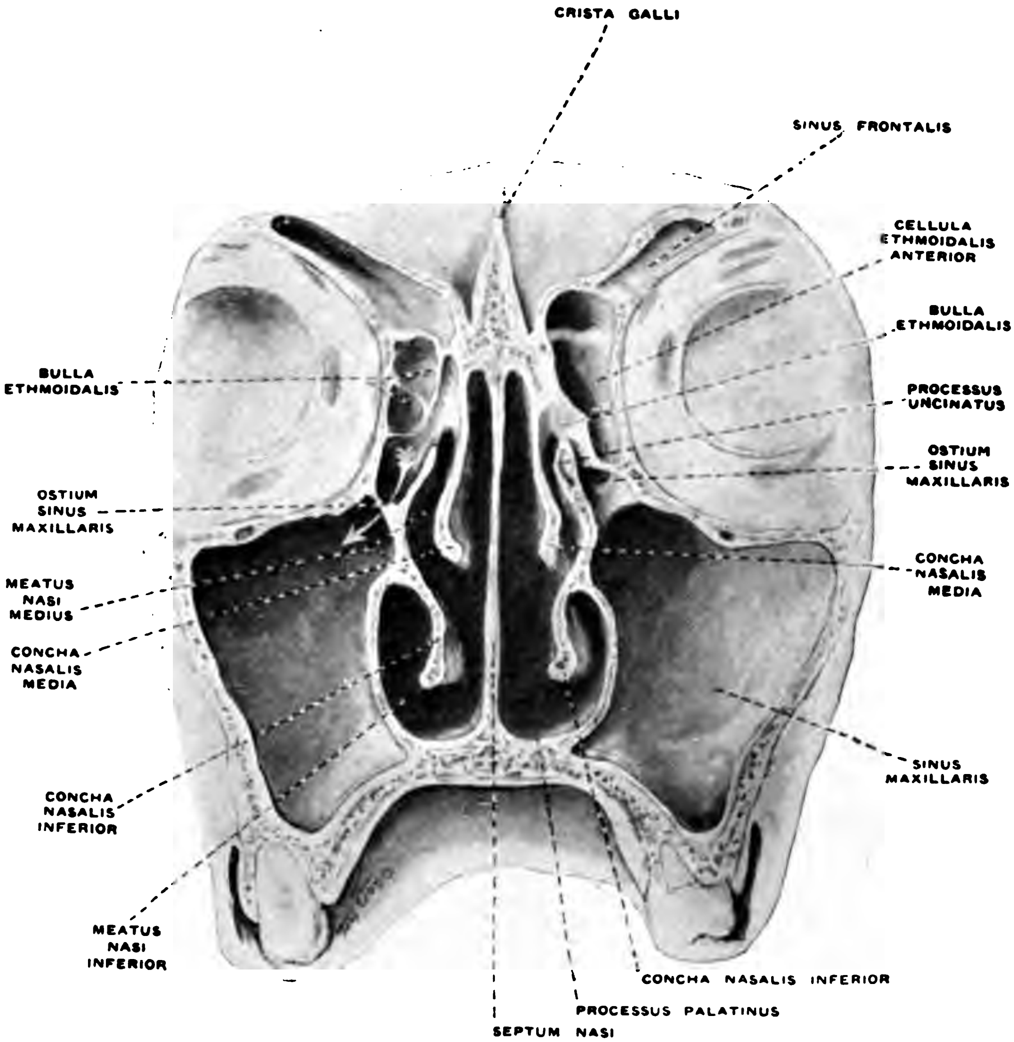


Fig. 13.

Coronal section through the nose and orbit.

bitale. Radiographs show the extent and shape of this wall and are therefore required before radical operative procedures are undertaken.

The relation of the posterior and superior wall to the brain has been studied extensively by Onodi, who found that this wall of the

frontal sinus may extend over the gyrus frontalis superior, gyrus frontalis medius and gyrus frontalis inferior. The inferior wall is in relation with the orbit (Fig. 13) and reaches often far back into the ethmoid labyrinth. As a rule it extends but a short distance posteriorly over the orbit while laterally it is usually limited to the inner and middle thirds, although in some instances it may reach the outer third. The septum between the two frontals is seldom directly in the median line, on which account either sinus may extend beyond it. The cavity is often subdivided by more or less complete septa which have the effect of establishing pockets in what would be otherwise a smooth cavity. Fig. 11 shows how irregular it may be. The sinus opens into the middle meatus by way of the infundibulum through an elongated canal (Figs. 7, 15, 16, 17 and 18) or simply as a foramen directly into the infundibulum. A very characteristic formation of the upper portion of the infundibulum is shown in Figs. 15 and 16, in which it lies behind an anterior ethmoidal cell, quite similar in appearance. In Fig. 16, the frontal is seen opening into the infundibulum through a canal. There has been considerable confusion in the application of the terms infundibulum and hiatus semilunaris. Onodi includes under the term hiatus semilunaris, the entire space between the uncinate process and the bulla ethmoidalis of the ethmoid bone, and accepts the designation of Killian, recessus frontalis, for the sharply outlined fossa into which the frontal often opens. Where a canal is present, he terms it ductus nasofrontalis. It is quite common for one or more ethmoid cells to open with the frontal through the infundibulum, furthermore the orifice of the maxillary sinus may lie in such a position that it receives the pus which flows from the frontal sinus and ethmoid cells, giving the impression that suppuration of the maxillary sinus is present.

Maxillary Sinus.—The maxillary sinus as will be seen in Fig. 14, is a cavity in the maxilla interposed between the alveolar process and the orbit and the external wall of the nose and the malar process. A portion of the anterior wall has been cut away bringing the cavity into view. That portion of the alveolar process covering the roots of the teeth has been cut away, to show their relation to the floor of the sinus. In the specimen illustrated the roots of the three molars and two bicuspids are in close relation with the sinus, two of the roots of the second molar making indentations into the floor. The cuspid lies anterior to the sinus, but it extends above the floor.

The floor of the sinus is by no means smooth or regular; as a rule there are bony septa present which divide it into pockets. Hence puncture through the alveolus will not necessarily result in satisfactory drainage. The floor of the nose is generally on a higher level than that of the sinus. (See Figs. 4 and 13).

The posterior limit of the maxilla separates the maxillary sinus from the zygomatic fossa (fossa infratemporalis). The floor of the orbit in part constitutes the roof of the sinus and the external wall of the nose, its internal wall. The canal for the infraorbital nerve forms in most instances a ridge on the roof of the sinus; however, the ridge may not be well marked and may be even absent. (Fig. 13.)

The opening of the sinus into the middle meatus is on the internal wall, generally in its upper part; at times there are accessory openings.

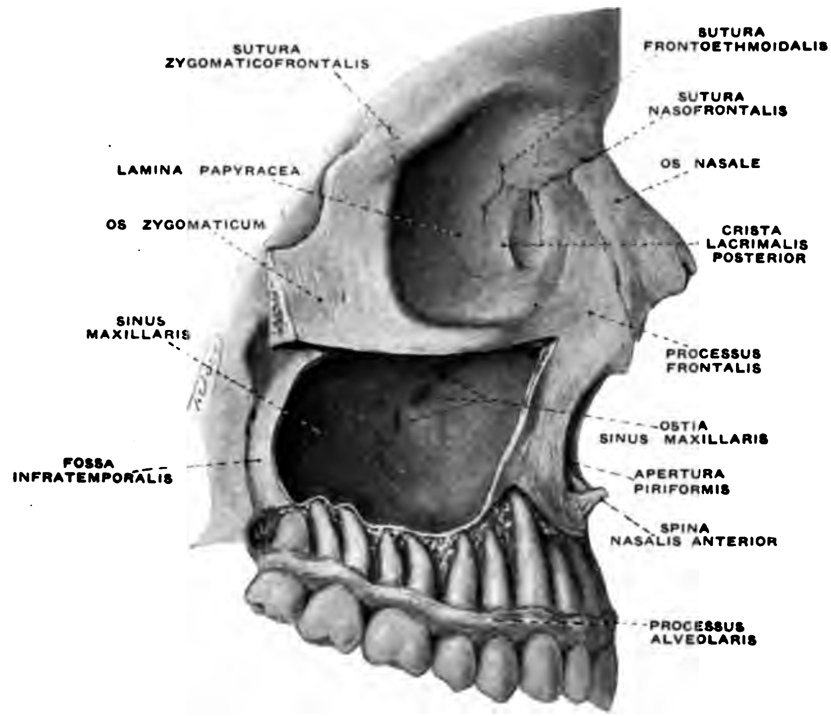


Fig. 14.

Right lateral view of bones of the face with maxillary sinus and roots of the teeth exposed.

Hence it is that pus in this sinus is evacuated through its opening more readily in the recumbent position; pus coming from the middle meatus may be determined to come from the maxillary sinus if it appears or increases when the head is lowered and the face is turned towards the side examined. This brings the orifice into the most dependent position and thus permits pus to flow out more readily. The position is not conducive to the flow of pus from the frontal sinus or the anterior ethmoid cells.

The maxillary sinus may be opened surgically:

1. Through the alveolar process by removing a tooth or in some instances without the removal of a tooth.

2. Through the anterior wall (in the fossa canina) in the mouth.

3. In the middle or inferior meatus, with or without resecting a part of the inferior turbinate.

4. By cutting away a part of the margin of the apertura piriformis through the nose and continuing the excision by removing a part of the external wall of the nose below the attachment of the inferior turbinate (Canfield's operation).

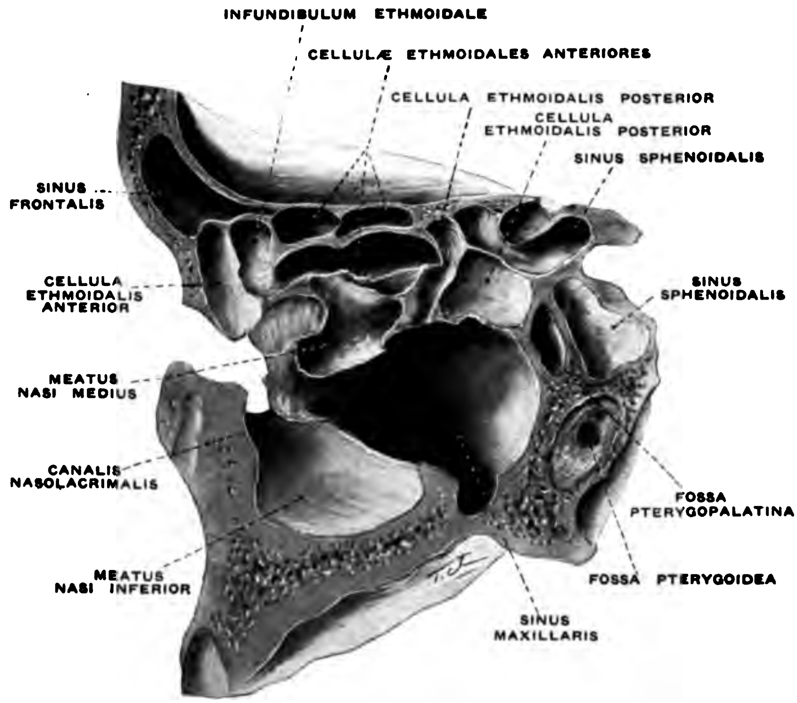


Fig. 15.

Sagittal section through the right side of nose and maxillary sinus. External portion.

Ethmoid Cells.—The ethmoid cells are divided into two groups, the anterior which open into the middle meatus and the posterior which open above the middle turbinate, generally in the superior meatus.

There is no uniformity as to the number, position or size of the cells in either group. They lie in the bony wall between the nasal cavities and the orbit, the frontal and sphenoid sinuses, and between the floor of the cranial cavity and the middle turbinate.

Sometimes an ethmoid cell may extend into the middle turbinate forming what is known as a concha bullosa. Such a cell as a rule has its opening in its upper part, and therefore drainage is unsatisfactory when any affection is present which causes it to fill up with fluid. The bulla ethmoidalis (Figs. 7 and 13) contains one or more ethmoid cells, generally belonging to the anterior group, although occasionally one is found opening into the superior meatus.

In the specimens illustrated in Figs. 15 and 16, a sagittal section has been made, so as to cut through the anterior attachment of the

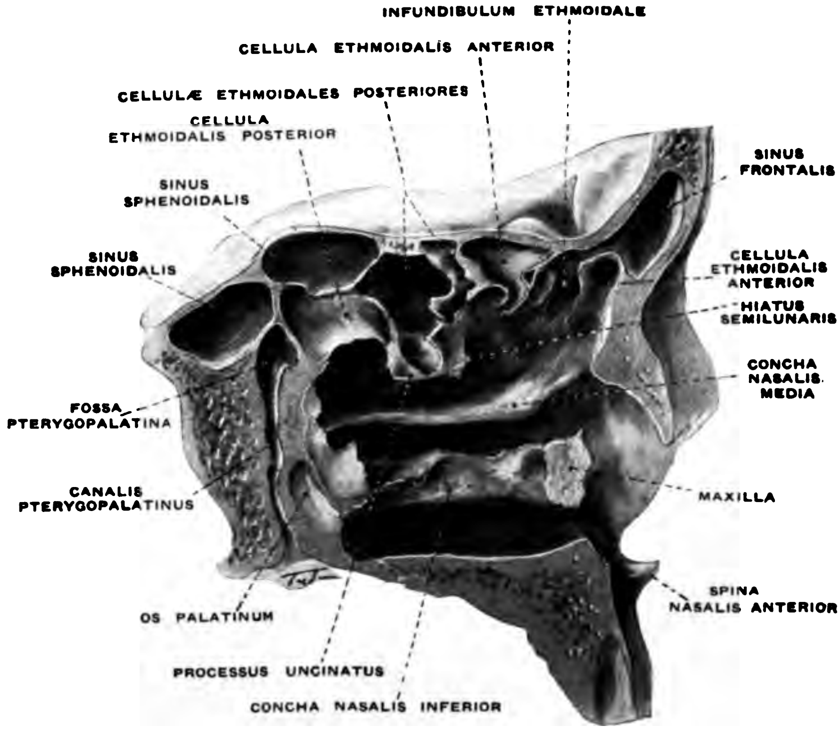


Fig. 16.
Sagittal section through the right side of the nose. Internal portion.

inferior turbinate to the maxilla, which is shown free except for its attachment to the palate bone. The middle turbinate is shown articulated with both the maxilla and palate bone. The uncinate process which assists in closing up the inner wall of the maxillary sinus projects downward from the lateral mass of the ethmoid. As will be noted it partakes in part of the general cellular arrangement of the bone in this position.

The frontal opening into the infundibulum ethmoidale is well shown

while adjacent anterior ethmoidal cells are quite typical. Behind these are the posterior ethmoid cells, and posterior to them, the sphenoid.

The specimen shows the pterygomaxillary canal throughout its entire extent. It will be observed that the upper part of the canal, where the sphenopalatine ganglion lies, may be entered by plunging

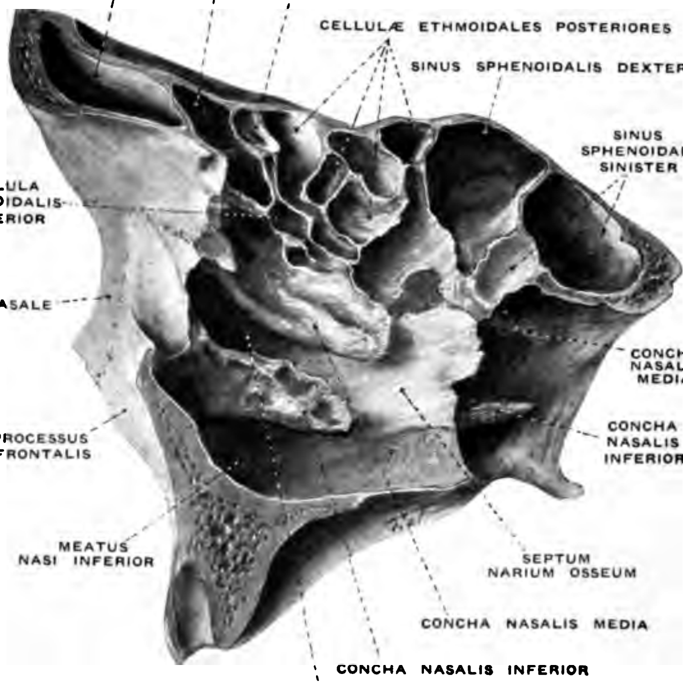


Fig. 17.

Sagittal section through the left side of the nose internal to that of Figs. 15 and 16. Inner portion.

a needle into the outer wall of the nose just above the posterior extremity of the middle turbinate.

An ethmoid cell lies anterior to the infundibulum running parallel to it and resembling it in shape and size. As has been already reported by the writer, a probe is likely to enter this particular type of cell, giving the surgeon the impression that he is in the frontal sinus. Sometimes this cell or another anterior ethmoid cell may project far into the frontal sinus, constituting what is known as a bulla frontalis.

The arrangement of the ethmoid labyrinth is shown in Figs. 17 and 18, which illustrate the two sides of a sagittal section of the nasal cavity made internal to the one in the specimen illustrated in the last two figures. On one side the posterior portions of the turbinate are left with their articulation with the palate bone, and on other their maxillary attachments are preserved.

Sphenoid Sinus.—The figures show two very large sphenoid sinuses, the right extending anteriorly to the left side far beyond the

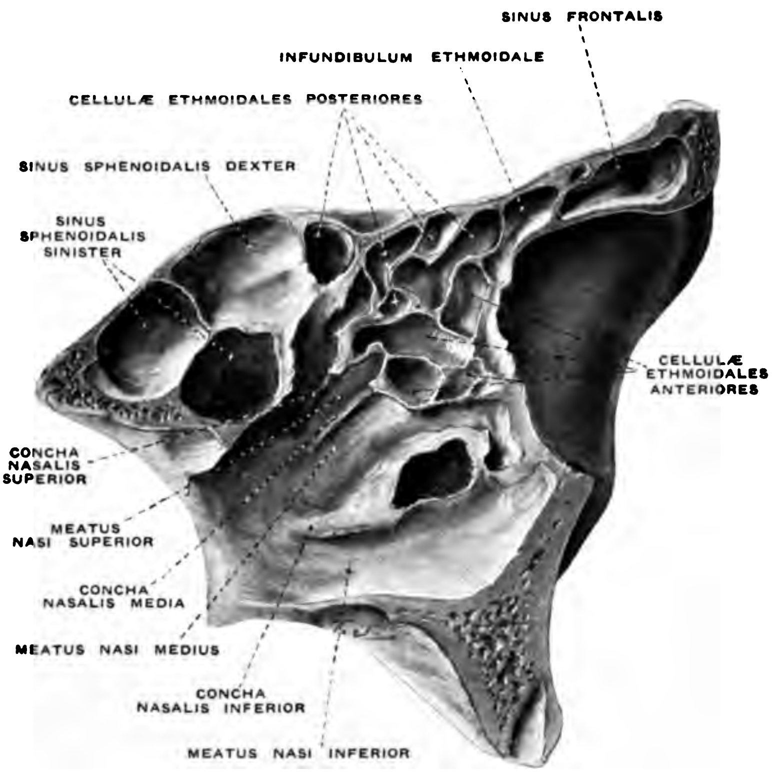


Fig. 18.

Sagittal section through the left side of the nose internal to that of Figs. 15 and 16. External portion.

median line, and the left posteriorly almost as far. The sphenoid sinuses occupy a greater or less amount of the body of the sphenoid. The two sinuses are not uniform in size, shape or relation.

A sphenoid sinus may extend but slightly to the opposite side, and sometimes it may grow to such an extent on the opposite side, that the other sphenoid is reduced to an exceedingly small size. On the other hand the last posterior ethmoid may almost entirely replace it. It may extend almost as far back as the Gasserian ganglion, and

to the basillar process of the occipital, and as far forward as the canalis opticus. Sphenoid sinuses of various shapes and sizes are illustrated in Figs. 35 to 55.

The walls of the sphenoid sinus vary in thickness not only in different individuals, but also in the two sinuses of the same head. This statement pertains more especially to the superior wall, the effect of which is to bring the pituitary body and optic nerves much

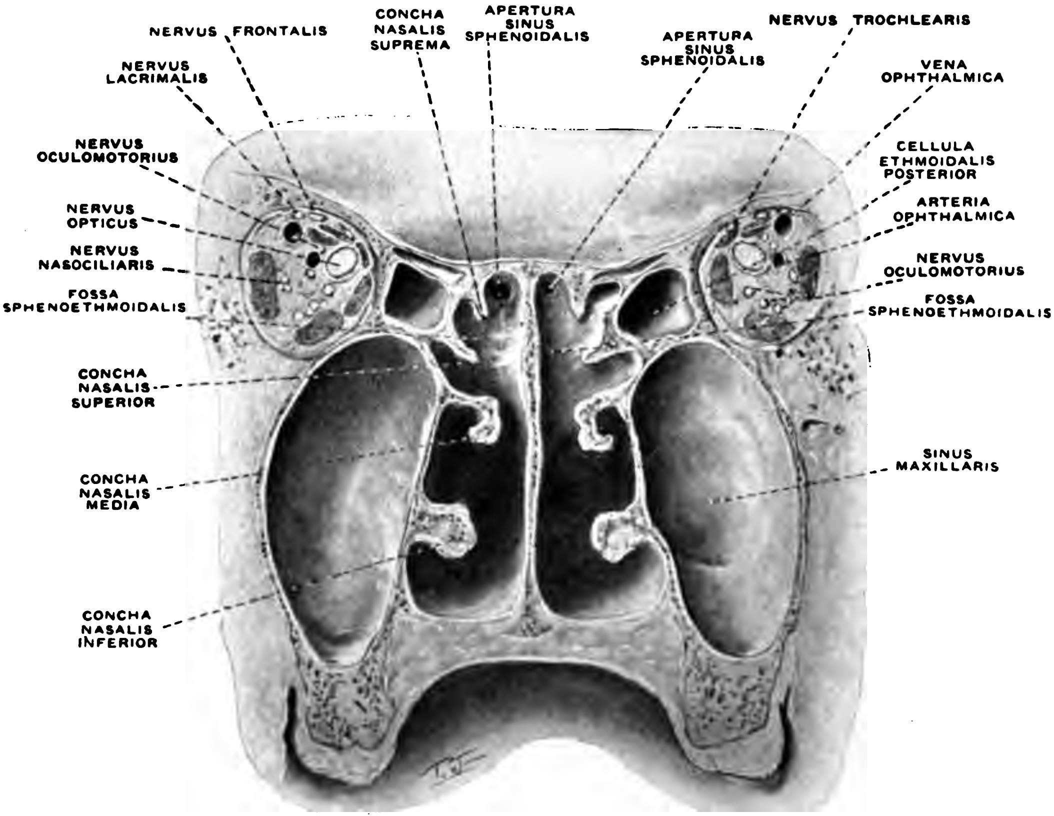


Fig. 19.

Coronal section through nose and orbit three mm. anterior to the anterior wall of the sphenoid sinuses.

closer to one sinus than to the other. The external wall, generally the thickest, lies between the sinus and the middle cranial fossa, and adjoins the sinus cavernosus and the carotid artery. The following nerves in addition to the optic are found in relation with the external wall, abducens, oculomotor, trochlear, ophthalmic and maxillary (Fig. 8).

The posterior wall articulates with the basillar process of the occipital. The inner wall or septum sinuum sphenoidalium is frequently

in the median line, but from what has already been stated, it may be exceedingly irregular in its position. (Fig. 57.)

The anterior wall is in relation with the nasal cavity (recessus sphenoethmoidalis) and the posterior ethmoidal cell. In the section (Fig. 19) the walls of the nasal cavities have been cut away 3 mm. anterior to the sinus, showing the relation of the anterior wall to the nasal cavities and the posterior ethmoid cells. The turbinates, four in number on each side are cut close to their posterior extremity. The choanæ are visible in the depths. Their position with respect to the sphenoid sinus and to the posterior portion of the nasal cavity is well shown. It will be observed that much of the nasal cavity lies above the choanæ, quite as great in size from below upward as the choanæ themselves. This figure shows how the sphenoid may be opened with or without the destruction of the posterior ethmoid cell. Compare this with Fig. 8, which gives a view of the sphenoid anteriorly from the pharynx.

The orifice of the sphenoid sinus, while always opening into the nose above the superior turbinate, varies considerably in its position. The following table shows the distance between the inferior margin of the opening, and the lowest level of the floor, and the highest level of the roof respectively, in fifteen heads measured by the writer:

DISTANCE BETWEEN THE INFERIOR MARGIN OF THE NASAL OPENING OF THE SPHENOID SINUS AND THE FLOOR AND ROOF OF THE SINUS

(In Millimeters)

HEADS	RIGHT		LEFT	
	FLOOR	ROOF	FLOOR	ROOF
VI.	17	13	13	11
VII.	7	15	20	14
VIII.	13	14	11	16
IX.	10	13	4	13
X.	13	9	8	12
XI.	12	14	11	15
XII.	4	4	14	12
XIII.	15	21	17	19
XIV.	16	22	8	10
XV.	2	2	14	13
XVI.	7	14	3	7
XVII.	12	12	7	12
XVIII.	6	4	5	14
XIX.	21	7	9	8
XX.	19	2	17	10

These figures show a wide variation, and yet it may be said that the orifice, as a rule, is midway between the roof and the floor. This is true for twenty out of thirty sinuses.

In XIX, XX, right, the orifice is in the upper third; in VII and XVI, right, and IX, XVI and XVIII, left, it is in the lower third; in the other twenty-three instances it is in the middle third.

It is relatively highest in head XX, right, where its distance from the roof is one-tenth of that between the roof and the floor. It is relatively lowest in IX, left, where it opens in the lower quarter of the anterior wall.

The relation of the cavernous sinus and of the third (oculomotorius), fourth (trochlearis), fifth (trigeminus), sixth (abducens) and the vidian nerves to the sphenoid sinus has been carefully studied by Sluder.

He found that the body of the sphenoid is covered above and laterally by the dura mater with the cavernous sinus between its external and internal surfaces, occupying a position for the most part above and lateral to the body. Within the cavernous sinus are found the internal carotid artery, and the third, fourth and sixth cranial nerves, the first division of the fifth lying in the lower part of its lateral wall. The sixth and third division of the fifth are the only ones of these nerves that are not at times in close association with this cell, that is, separated from it by a very thin layer of bone, and even the third division of the fifth is sometimes also in close association with it. The sixth is uniformly placed on the lateral aspect of the carotid while within the cavernous sinus and is always removed from this bony wall.

The fact which determines the relations of these nerve trunks to the sphenoid sinus is the size of the cavernous sinus rather than the size of the sphenoid sinus. A large sphenoid sinus prolonged backward and outward may closely approach the third division of the fifth in the foramen ovale or even the Gasserian ganglion. (See Fig. 47.)

The second division of the fifth is in close association with the sphenoid sinus when it extends laterally to the foramen rotundum. The first division of the fifth comes into close association with the sphenoid sinus anteriorly when the cavernous sinus is small in either direction. The third and fourth nerves may be in relation with the sphenoid sinus when it is prolonged outward into the anterior clinoid process or lesser wing of the sphenoid. The sixth nerve comes into these relations in the sphenoidal fissure (fissura orbitalis superior) when the sinus is prolonged into the great wing of the sphenoid (ala magna).

This close association of the sphenoid sinus with the second di-

Fig. 20. (Head VI.)

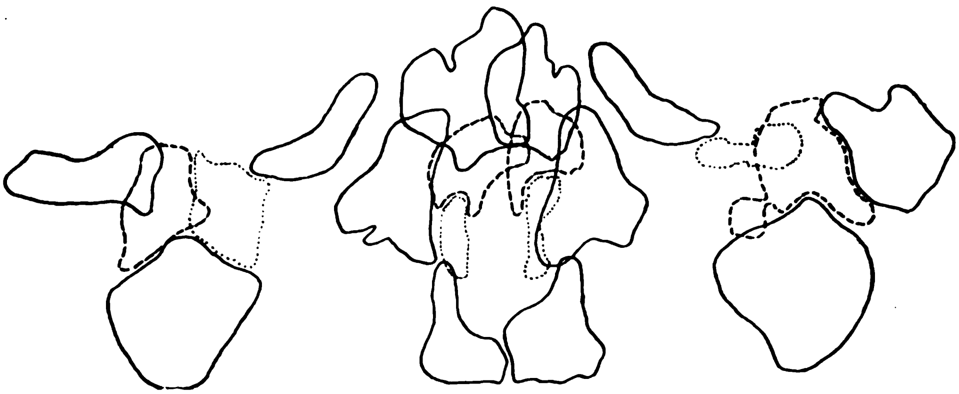


Fig. 21. (Head VII.)

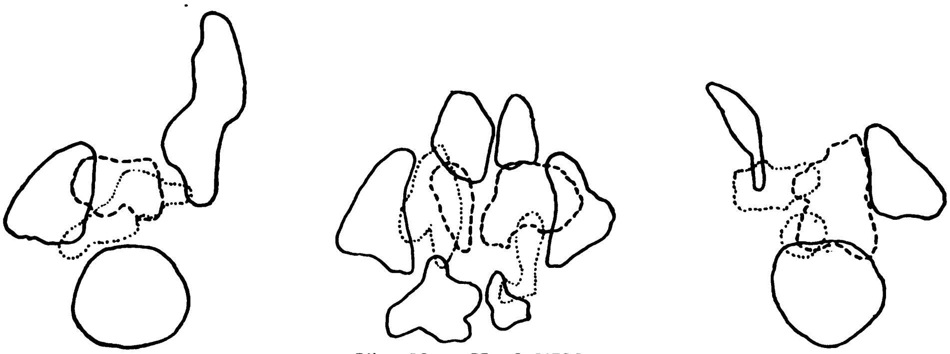


Fig. 22. (Head VIII.)

Lateral and superior reconstructions of the accessory sinuses of the nose.

Fig. 23. (Head IX.)

Fig. 24. (Head X.)

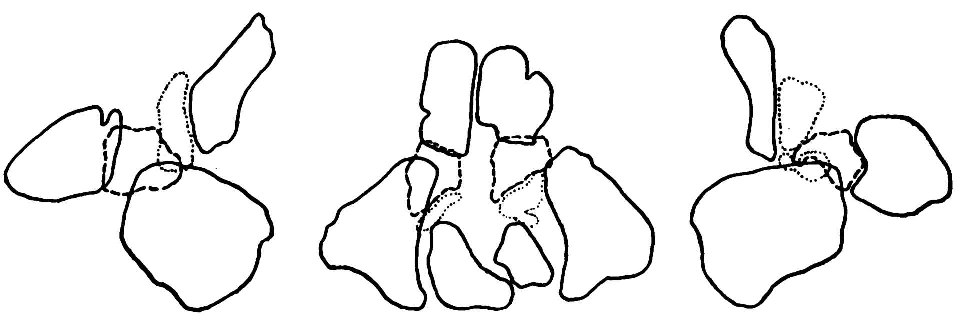


Fig. 25. (Head XI.)

Lateral and superior reconstructions of the accessory sinuses of the nose.

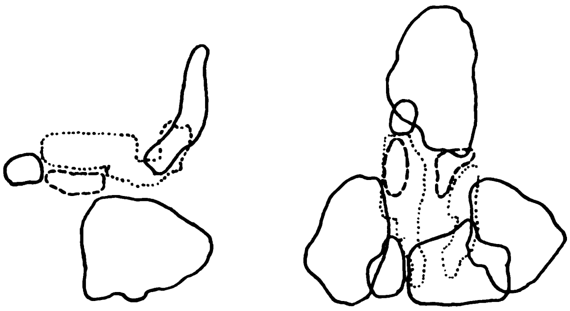


Fig. 26. (Head XII.)

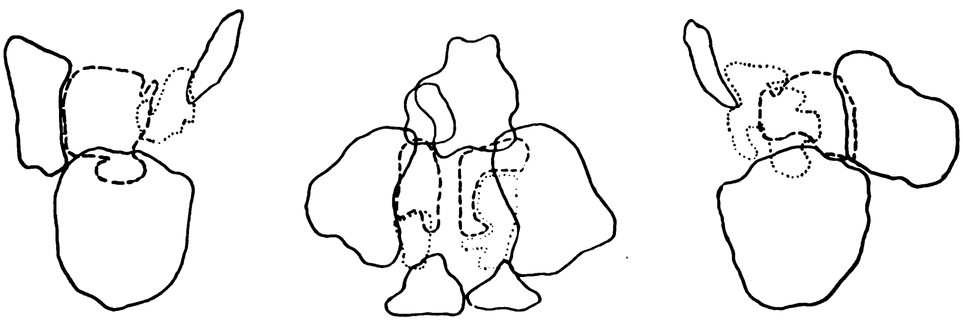


Fig. 27. (Head XIII.)

Fig. 28. (Head XIV.)

Lateral and superior reconstructions of the accessory sinuses of the nose.

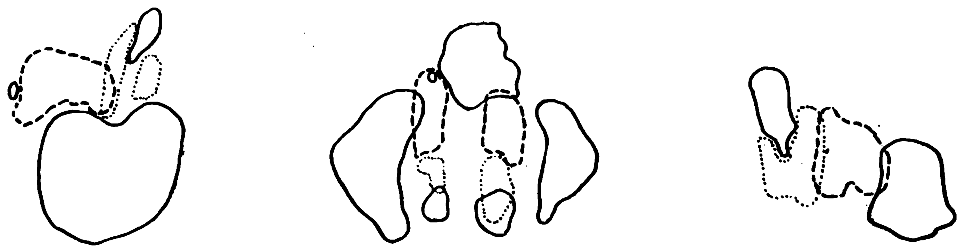


Fig. 29. (Head XV.)

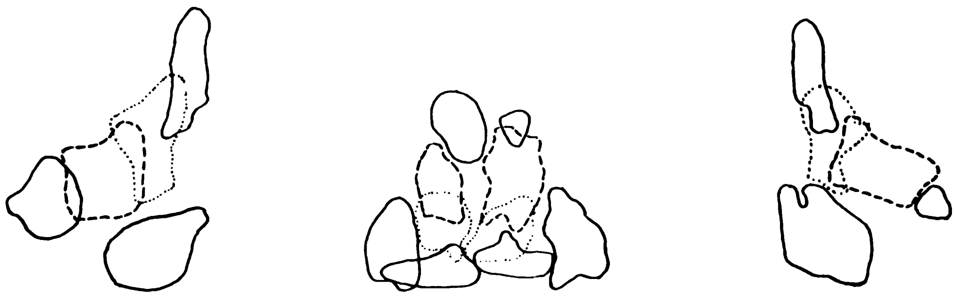


Fig. 30. (Head XVI.)

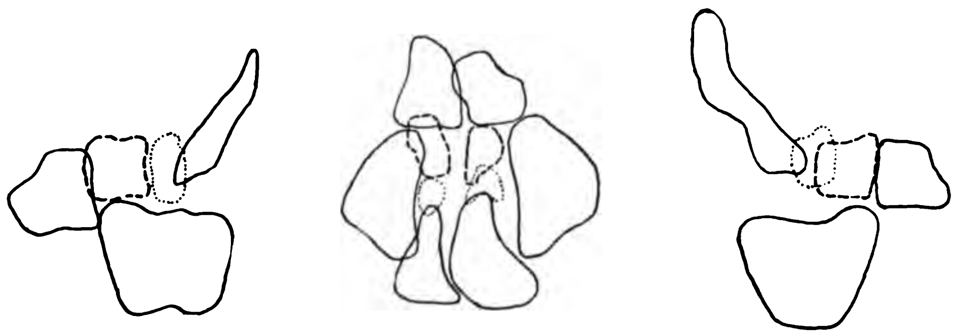


Fig. 31. (Head XVII.)

Lateral and superior reconstructions of the accessory sinuses of the nose.

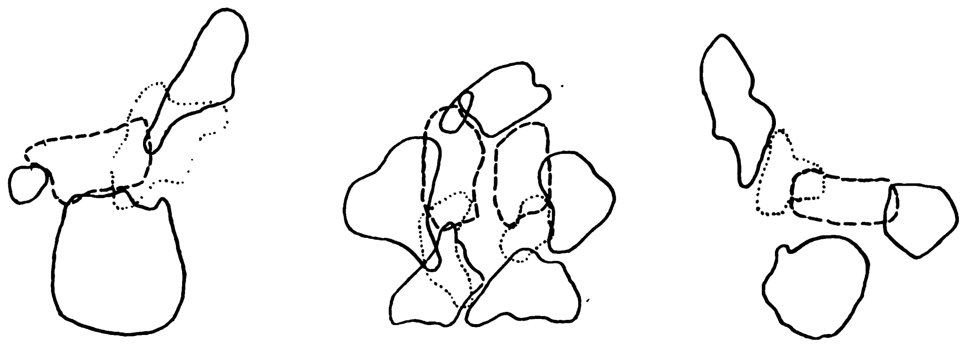


Fig. 32. (Head XVIII.)

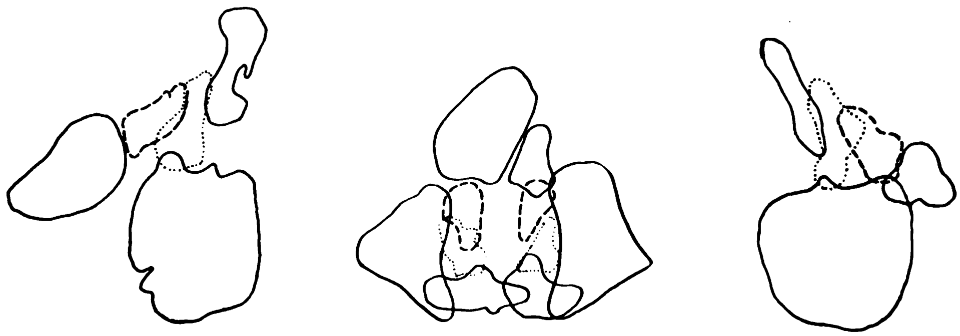


Fig. 33. (Head XIX.)

Fig. 34. (Head XX.)

Lateral and superior reconstructions of the accessory sinuses of the nose.

vision of the fifth in the foramen rotundum may be established as early as the third year of life, and with the vidian nerve in its canal as early as the sixth year.

Variations of the Sinuses in Size and Shape.

The reconstruction method is perhaps the best for illustrating the variations in size and shape of the sinuses. Reconstructions of the sinuses in fifteen heads are shown, right, left and superior. In Figs. 20 to 34 inclusive, the central illustration is the superior view, the right shows the left set of sinuses, and the left the right set (so placed in order to make orientation easy). The anterior ethmoid cells are represented by dotted lines and the posterior by broken lines. The other sinuses are drawn with solid lines, as they are obvious, viz., in the central illustration the maxillary are the most external, the frontal anterior, and the sphenoid posterior; in the lateral, the frontal is superior, the sphenoid posterior, and the maxillary inferior. The ethmoid cells of each group are drawn as if they constituted a single sinus, except where the cells were too far distant from the group. As the figures are reduced to one-half the natural size, it is easy to estimate the extent of the sinuses.

In the central figures the extent of the sinuses anteroposteriorly and laterally is shown, and in the right and left figures, superoinferiorly and anteroposteriorly. The corresponding diameters may be thus determined.

Frontal Sinus.—While there is a great diversity of shapes to be found in the different frontal sinuses, there is rather more uniformity of shape and size in the two frontals of the same head. The dimensions in millimeters are as follows:

DIAMETERS OF THE FRONTAL SINUS
(In Millimeters)

HEAD	ANTEROPOSTERIOR		SUPEROINFERIOR		LATERAL	
	R.	L.	R.	L.	R.	L.
VI.	15	18	24	30	20	32
VII.	32	33	28	26	22	26
VIII.	22	16	51	28	25	11
IX.	17	21	27	36	21	37
X.	17	17	40	37	27	22
XI.	22	16	38	38	22	15
XII.	16	22	34	45	10	27
XIII.	17	13	25	22	21	18
XIV.	26	21	45	37	42	37
XV.	9	12	14	24	7	11
XVI.	12	13	35	30	26	21
XVII.	26	30	35	43	17	23
XIX.	28	21	39	41	25	30
XVIII.	12	17	30	31	28	20
XX.	26	31	46	45	32	24

The variations in the size of the frontals may be summed up as follows:

Range, anteroposterior 9 to 33, superoinferior 14 to 51, lateral 7 to 42. Usual, leaving out five highest and lowest, anteroposterior 15 to 26, superoinferior 26 to 40, lateral 17 to 30. Average, anteroposterior 21, superoinferior 34, lateral 23.

The largest sinus is that of XIV (Fig. 28) right, in which the diameters are 26, 45, 42, and the smallest that of XV (Fig. 29) right, having the diameters 9, 14, 7.

Maxillary Sinus.—As a rule the maxillary sinuses in a given head are fairly uniform in size and shape; the dimensions of the maxillary sinuses are shown in the following table:

DIAMETERS OF THE MAXILLARY SINUS AND DISTANCE OF THE OPENING FROM THE FLOOR OF THE CAVITY

(In Millimeters)

	ANTERO-POSTERIOR		SUPERO-INFERIOR		LATERAL		DISTANCE OF OPENING FROM FLOOR OF CAVITY	
HEAD	R.	L.	R.	L.	R.	L.	R.	L.
VI.	39	40	42	32	30	25	36	28
VII.	40	42	41	47	28	29	32	39
VIII.	32	30	28	29	19	18	24	25
IX.	17	20	17	21	8	11	15	14
X.	39	37	37	40	33	30	36	38
XI.	40	40	37	39	31	29	33	34
XII.	34	29	28	28	28	25	21	23
XIII.	37	40	45	43	29	32	32	32
XIV.	37	42	38	40	25	25	23	21
XV.	40	33	38	34	24	26	33	30
XVI.	25	26	23	26	15	17	18	24
XVII.	35	37	31	33	32	23	22	25
XVIII.	35	26	38	26	26	19	33	21
XIX.	36	42	45	42	27	32	40	38
XX.	36	35	39	36	25	21	36	28

The variations are as follows:

Range, anteroposterior diameter 17 to 42, superoinferior 17 to 47, lateral 8 to 33, orifice to floor 14 to 40. Usual, leaving off highest and lowest five, anteroposterior 29 to 40, superoinferior 28 to 42, lateral 19 to 30, orifice to floor 21 to 36. Average, anteroposterior 38, superoinferior 38, lateral 23.8, orifice to floor 29. The largest is VII (Fig. 21) left, 42, 47, 29, the smallest is IX (Fig. 23) right, 17, 17, 8. It will be noted that leaving out a few of the extremes, the maxillary sinuses are more uniform than any of the other sinuses.

Ethmoid Cells.—To show the great complexity of the ethmoid cells and the variability of their size and shape, it has been deemed advisable to consider the diameters of the ethmoid labyrinth and of the anterior and posterior groups of cells respectively. The dimensions are as follows:

DIAMETERS OF THE ETHMOID LABYRINTH
(In Millimeters)

HEAD		LABYRINTH			ANTERIOR ETHMOID			POSTERIOR ETHMOID		
		Antero-posterior	Supero-inferior	Lateral	Antero-posterior	Supero-inferior	Lateral	Antero-posterior	Supero-inferior	Lateral
VI.	Right	37	23	18	23	22	8	28	23	28
	Left	36	20	13	22	15	9	20	17	12
VII.	Right	43	34	26	22	31	8	26	34	27
	Left	47	35	20	27	12	9	30	36	20
VIII.	Right	32	26	19	32	20	16	22	17	11
	Left	47	32	26	24	25	11	22	32	26
IX.	Right	34	39	20	21	33	18	23	26	12
	Left	30	36	20	20	32	19	21	28	23
X.	Right	35	28	14	19	25	11	20	17	13
	Left	35	28	15	21	26	15	22	19	14
XI.	Right	24	33	15	10	26	11	20	18	13
	Left	23	29	16	14	27	11	17	15	16
XII.	Right	40	20	12	40	17	12	15	6	8
	Left	34	17	12	30	17	9	13	10	11
XIII.	Right	35	31	12	14	18	9	26	23	12
	Left	35	35	18	26	35	14	25	31	18
XIV.	Right	45	59	26	26	57	26	27	30	17
	Left	46	57	28	30	50	29	32	31	12
XV.	Right	33	26	9	9	7	24	24	20	9
	Left	37	26	11	17	8	26	20	22	11
XVI.	Right	32	40	15	20	35	14	22	26	12
	Left	35	31	22	19	28	18	28	23	16
XVII.	Right	27	19	12	9	19	7	18	17	11
	Left	22	18	10	12	16	10	16	17	10
XVIII.	Right	54	33	16	22	18	14	14	28	15
	Left	38	25	15	30	34	12	33	23	15
XIX.	Right	24	25	11	16	25	13	17	18	11
	Left	25	28	11	15	28	11	17	20	9
XX.	Right	35	40	15	28	38	11	27	35	14
	Left	32	42	13	15	29	12	25	38	13

These figures show the following:

Ethmoid Labyrinth.—Range, anteroposterior diameter 22 to 54, superoinferior 17 to 59, lateral 9 to 28. Usual, leaving out five highest and lowest, anteroposterior 27 to 43, superoinferior 23 to 36, lateral 12 to 20. Average, anteroposterior 35, superoinferior 31.6, lateral 16.3.

The largest is that of XIV (Fig. 28) left, 46, 57, 28, and the smallest, XVII (Fig. 31) left, 22, 18, 10.

Anterior Ethmoid.—Range, anteroposterior 9 to 40, superoinferior 7 to 57, lateral 7 to 29. Usual, leaving out five highest and lowest, anteroposterior 14 to 27, superoinferior 17 to 34, lateral 9 to 18. Average, anteroposterior 21, superoinferior 25.6, lateral 14.

The largest is that of xiv (Fig. 28) left, 30, 50, 29, and the smallest that of xvii (Fig. 31) right, 9, 19, 7.

Posterior Ethmoid.—Range, anteroposterior 13 to 33, superoinferior 6 to 38, lateral 8 to 28. Usual, leaving out five highest and lowest, anteroposterior 17 to 26, superoinferior 17 to 31, lateral 11 to 18. Average, anteroposterior, 22.3, superoinferior 23.3, lateral 14.7.

The largest is that of vii (Fig. 26) left, 30, 36, 20, and the smallest that of xii (Fig. 26) right, 15, 6, 8.

Sphenoid Sinus.—There is a tremendous variation in the dimensions of the thirty sphenoid sinuses, as shown in the following table:

DIAMETERS OF THE SPHENOID SINUSES
(In Millimeters)

HEAD	ANTEROPOSTERIOR		SUPEROINFERIOR		LATERAL	
	R.	L.	R.	L.	R.	L.
VI.	35	15	30	24	31	12
VII.	42	36	22	34	34	25
VIII.	25	20	27	25	16	12
IX.	21	14	23	17	17	13
X.	17	14	22	20	17	11
XI.	31	27	26	26	14	19
XII.	9	39	8	26	7	24
XIII.	16	33	36	36	14	27
XIV.	24	10	38	18	35	10
XV.	2	23	4	27	2	21
XVI.	20	9	21	10	14	8
XVII.	24	14	24	19	17	17
XVIII.	9	19	10	19	9	24
XIX.	32	20	28	17	27	12
XX.	29	30	21	27	28	34

The anteroposterior diameter varies from 2 mm. in xv (Fig. 29) right, to 42 mm. in vii (Fig. 21) right; the superoinferior from 4 in xv (Fig. 29) right, to 38 in xiv (Fig. 28) right; lateral from 2 in xv (Fig. 29) right, to 35 in xiii (Fig. 27) right.

The sphenoid sinus of xv (Fig. 29) right, is by far the smallest, with diameters 2, 4 and 2; the next smallest being xii (Fig. 26) right, with diameters 9, 8 and 7. That of vii (Fig. 21) right, is the largest, with diameters 42, 22 and 34; while that of vi (Fig. 20) right, is next largest, with diameters 35, 30 and 31.

The average diameters of the thirty sinuses are as follows: Anteroposterior 21.5, superoinferior 22.8, lateral 18.4. Excluding five extremes, smallest and largest, the range of the remaining twenty, which may be considered as common, is as follows: Anteroposterior 14 to 32, superoinferior 17 to 27, lateral 11 to 27.

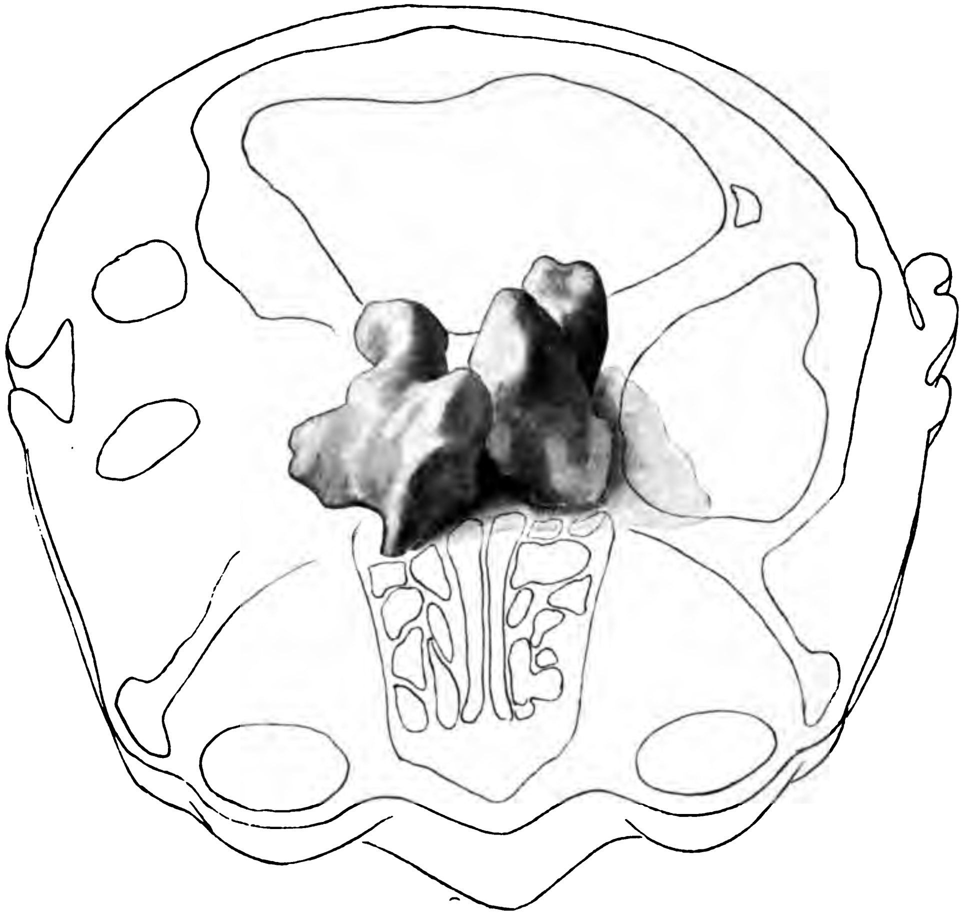


Fig. 35. (Head VII.)
Plaster casts of sphenoid sinuses, placed in situ.

A glance at the reconstruction of the sphenoid sinuses (Figs. 20 to 34) shows the great variety of size and shape. The right sphenoid xv (Fig. 29) is but little larger than its opening into the nasal cavity, which is in its accustomed position. It is replaced almost entirely by the left sphenoid, which is in relation with the optic chiasm, and both nerves. Both sphenoids of vii are exceedingly large (Fig. 21) and extend far behind the optic chiasm, sharing this feature with vi (Fig.

20) right, xii (Fig. 26) left, xiii (Fig. 27) left, xvii (Fig. 31) right, and xix (Fig. 33) right.

There is likewise great disparity in the size of the two sphenoid

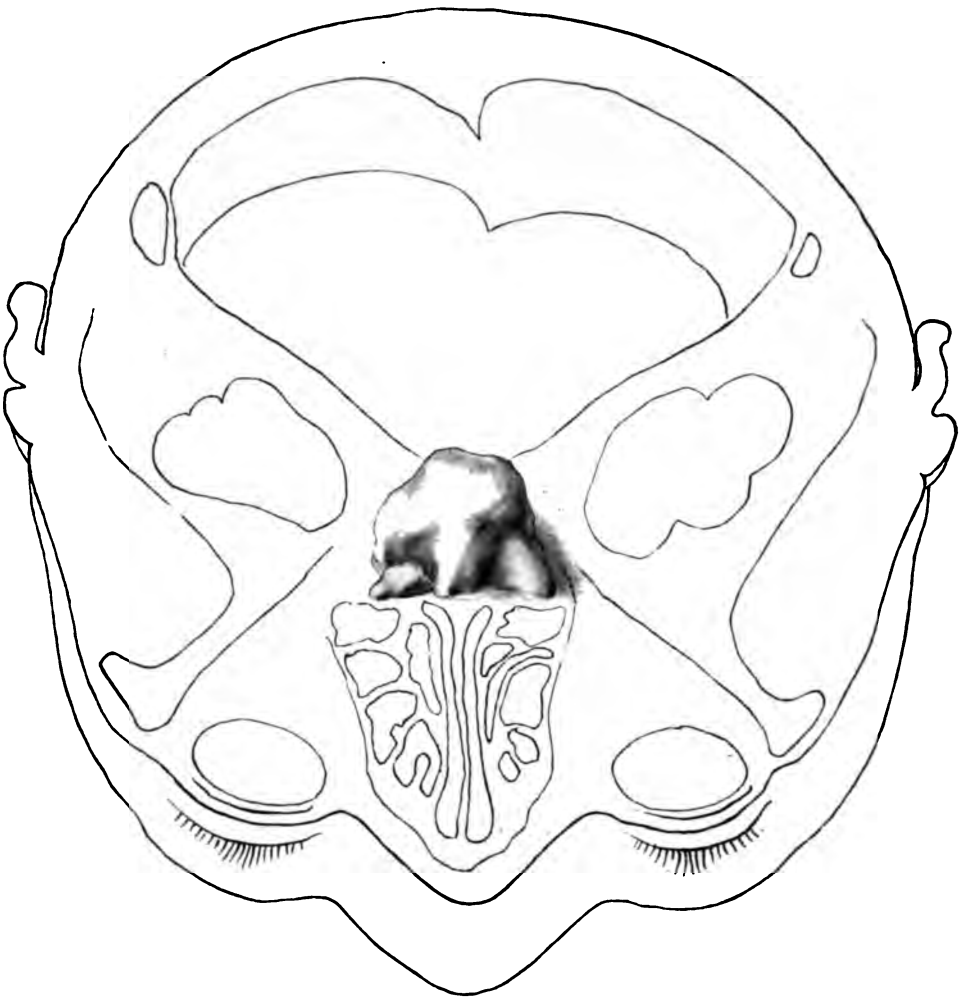


Fig. 36. (Head XII.)
Plaster casts of sphenoid sinuses, placed in situ.

sinuses in vi (Fig. 20), xii (Fig. 26), xiv (Fig. 28), xv (Fig. 29) and xix (Fig. 33).

In xvi neither sphenoid is in relation with the left optic nerve (Fig. 30). A large posterior ethmoid cell replaces the left sphenoid which is greatly reduced in size.

Superficial Area and Cubical Capacity of the Sinuses.

In order to determine the superficial area and cubical capacity of the sinuses, it is necessary to make casts of them and subject these

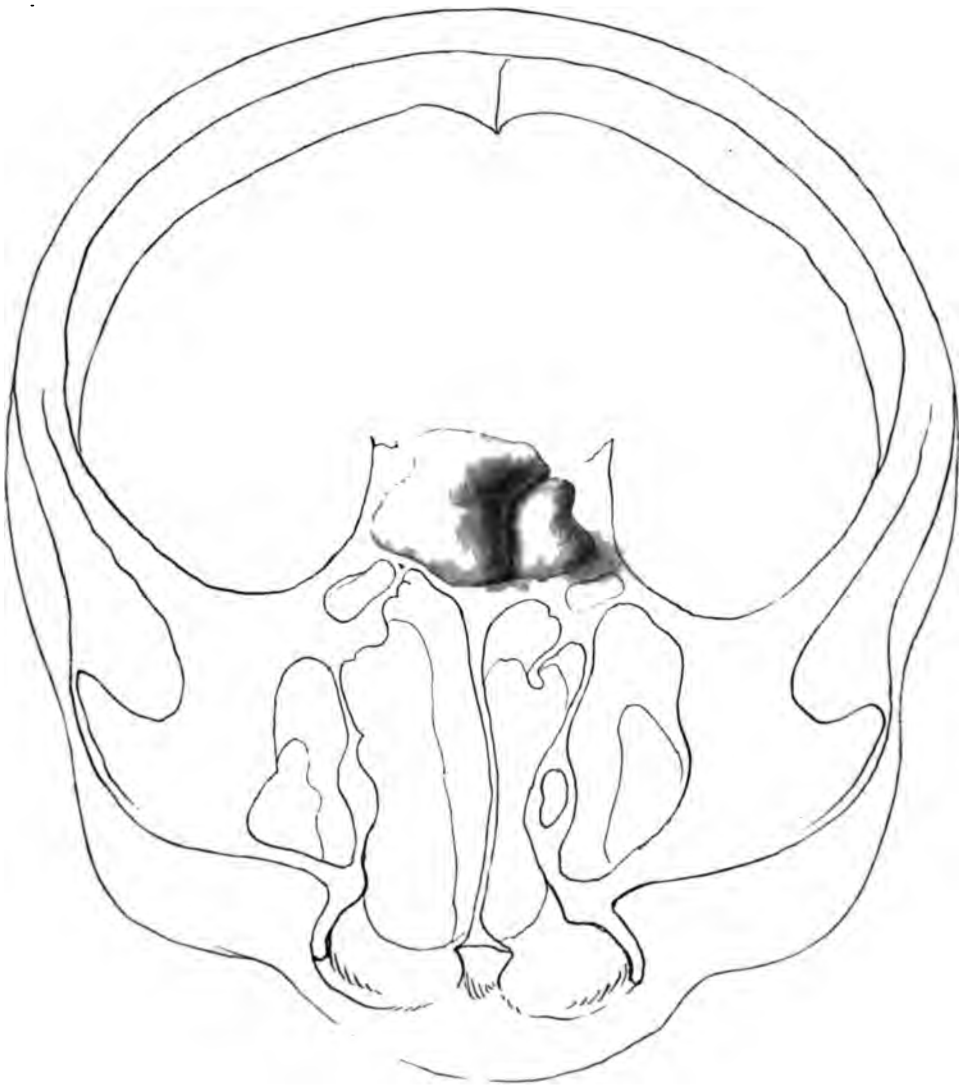


Fig. 37. (Head XIV.)
Plaster casts of sphenoid sinuses, placed in situ.

to some standard of measurements. Braune and Clasen found the cubical capacity by volumetric measurements of metallic casts of the sinuses. The writer presented a method at the International Laryngo-

Rhinological Congress in Berlin in 1911, by which both the cubical capacity and the superficial area (for the first time) were determinable from plaster casts made of the sinuses (except the ethmoidal) in serial sections, and then properly united according to the methods used by

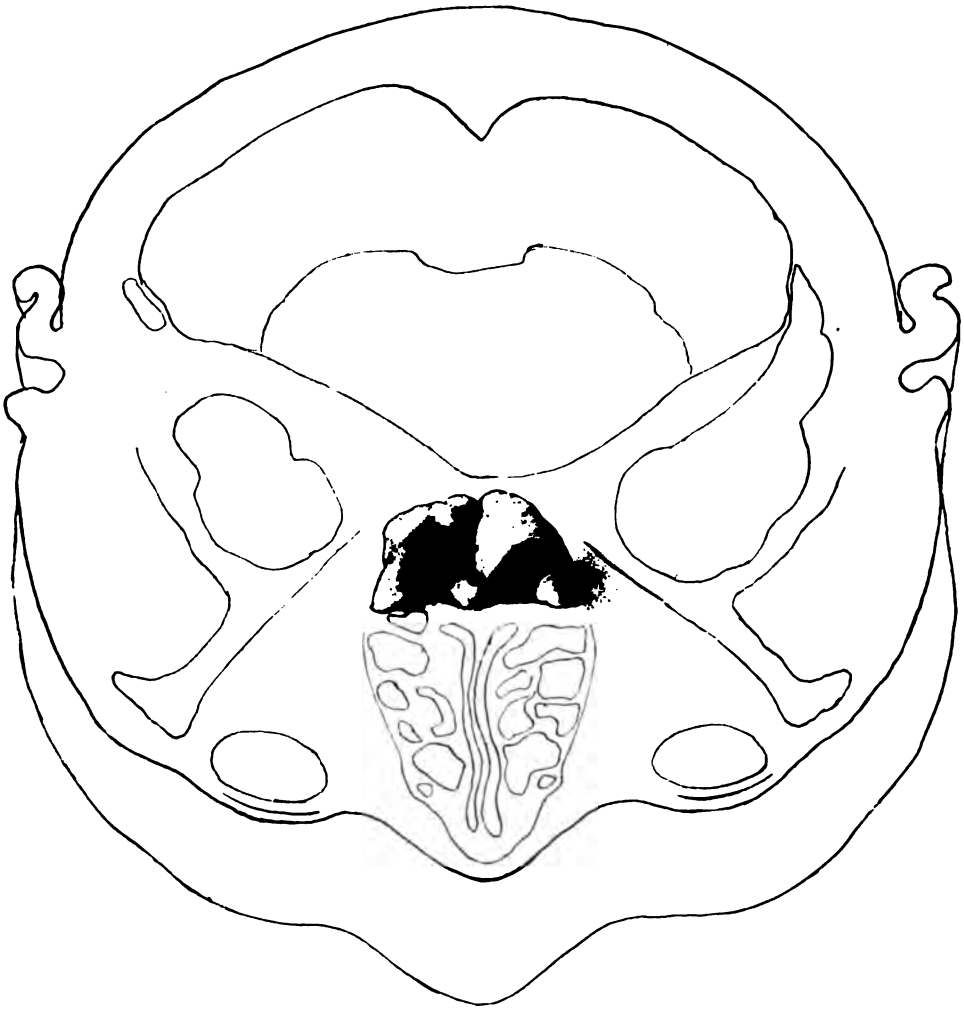


Fig. 38. (Head XXIII.)
Plaster casts of sphenoid sinuses, placed in situ.

dentists. A number of illustrations of such casts of the sphenoids are here presented, the casts being placed in proper position in the lowest section. A far better understanding of the extent and variability of the sphenoid sinuses is secured by this method than by any other.

It will be observed that the sphenoid sinuses although showing little resemblance to one another in the different heads, are fairly uniform in shape and size in VII (Fig. 35), XXIII (Fig. 38) and XXXV (Fig. 40).

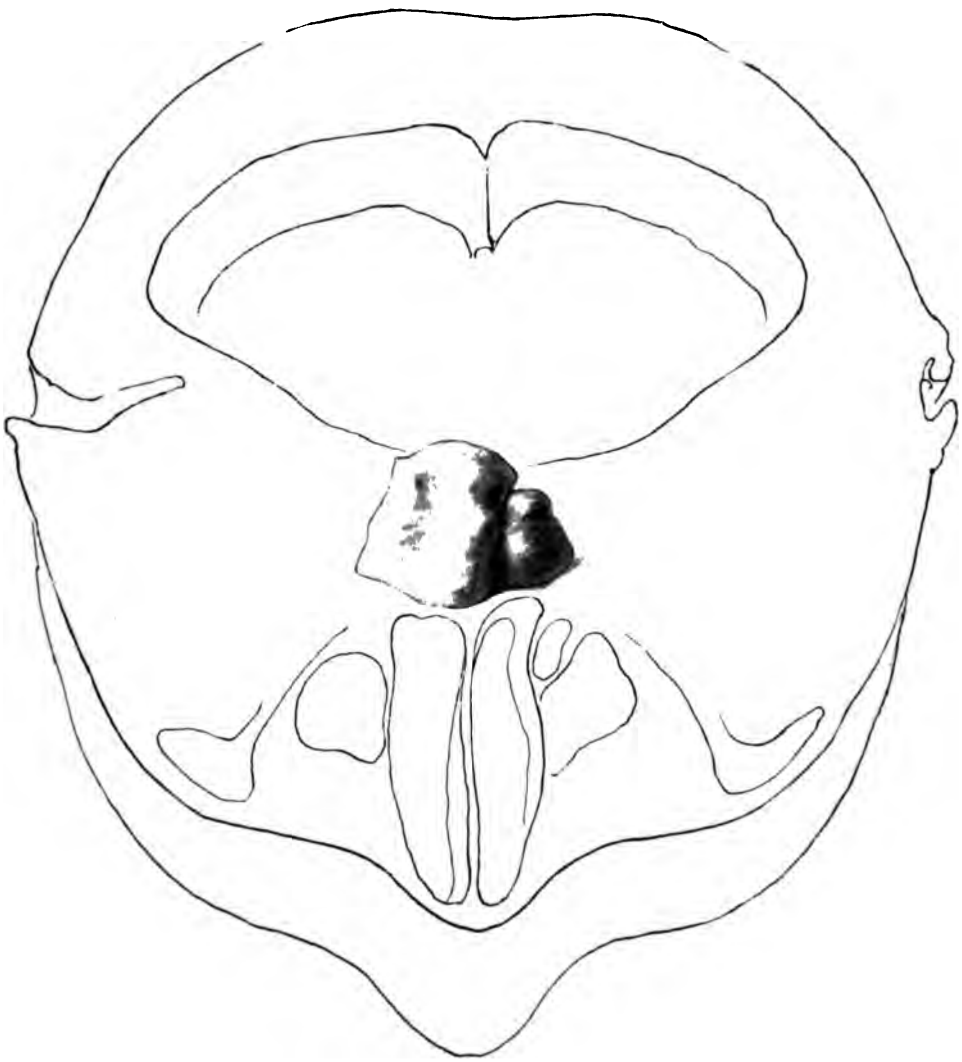


Fig. 39. (Head XXVI.)
Plaster casts of sphenoid sinuses, placed in situ.

These are all large except XXIII. The greatest difference is to be seen in XII (Fig. 36) in which the right sphenoid is reduced to a cavity 2 by 2 by 4 mm. XIV (Fig. 37) and XXVI (Fig. 39) show considerable difference in the size of the two sphenoids.

The results of the measurements may be summarized as follows:

	SUPERFICIAL AREA IN SQUARE CENTIMETERS		CUBICAL CAPACITY IN CUBIC CENTIMETERS	
	Greatest	Least	Greatest	Least
Sphenoid,	28.2	2.4	11.8	0.6
Frontal,	32.3	5.5	8.2	0.9
Maxillary,	52.3	12.1	28.4	4.5

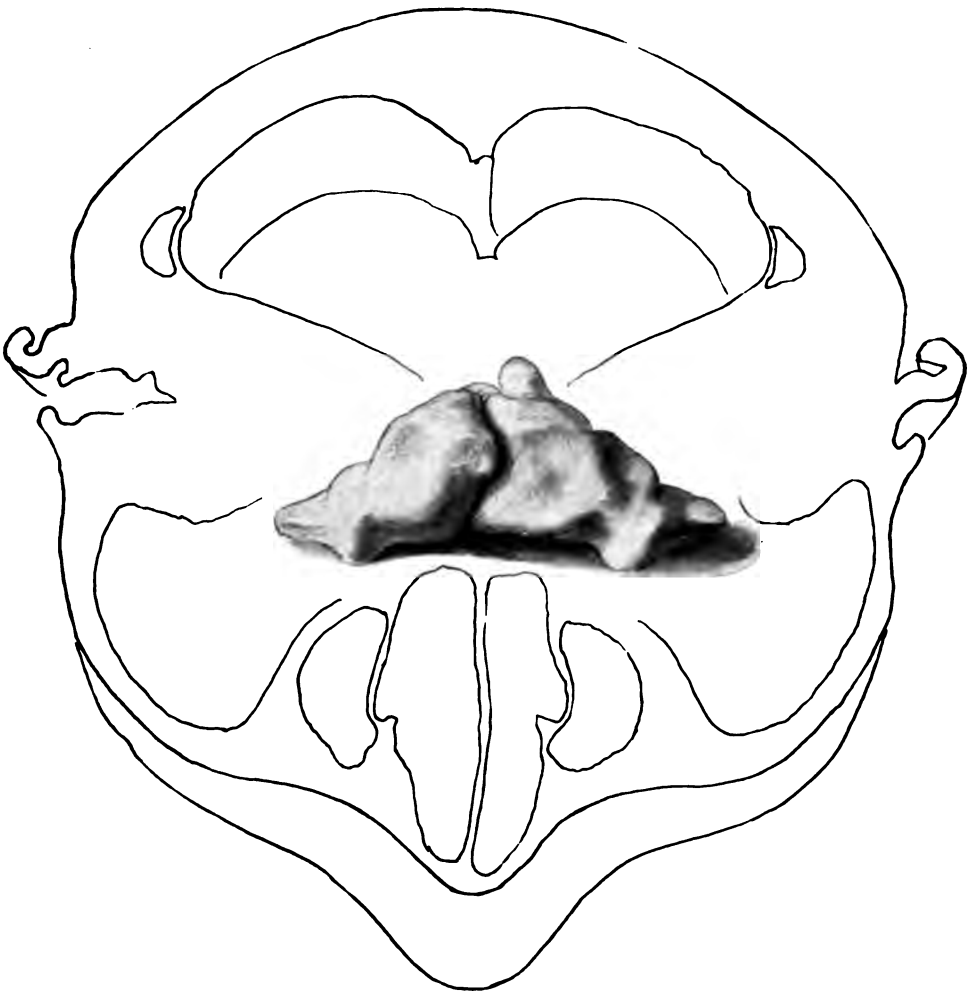


Fig. 40. (Head XXXV.)
Plaster casts of sphenoid sinuses, placed in situ.

Optic Chiasm and Nerve.

The relation of these structures to the nose and accessory sinuses is of importance from the standpoint of both pathology and surgery.

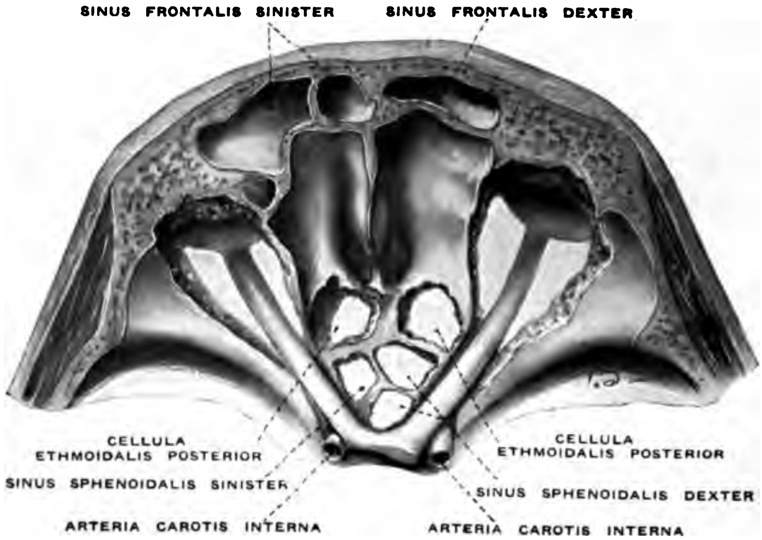


Fig. 41. (Head VI.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

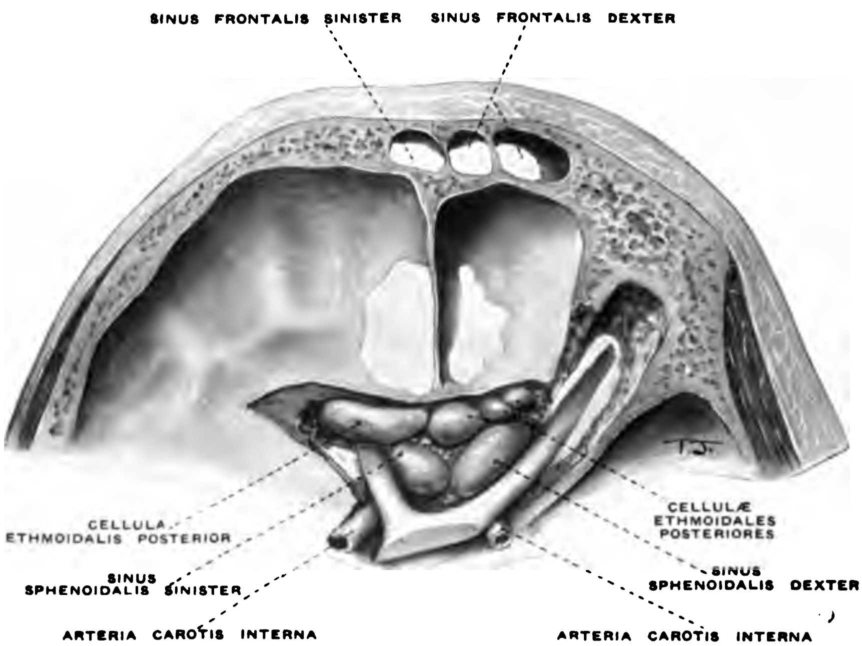


Fig. 42. (Head VII.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

The author has made a study of this in the fifteen heads illustrated in Figs. 41 to 55 inclusive. These are the same heads of which reconstructions were made as shown in Figs. 20 to 34 inclusive.

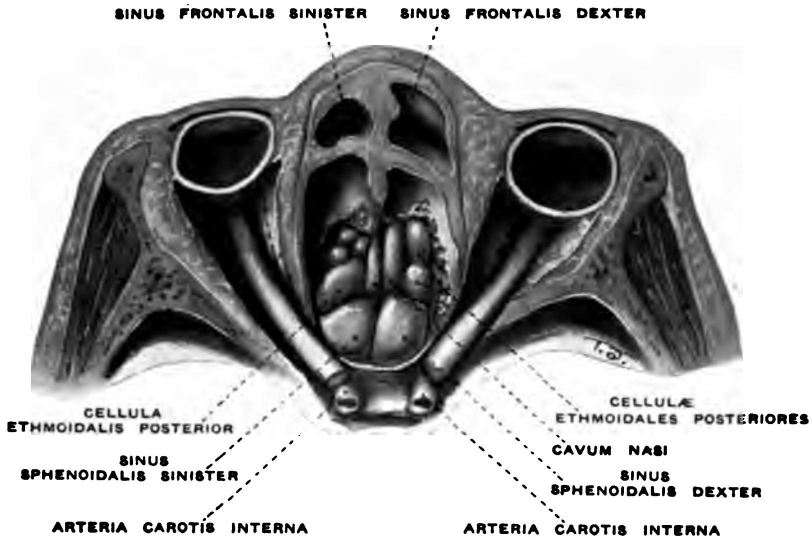


Fig. 43. (Head VIII.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

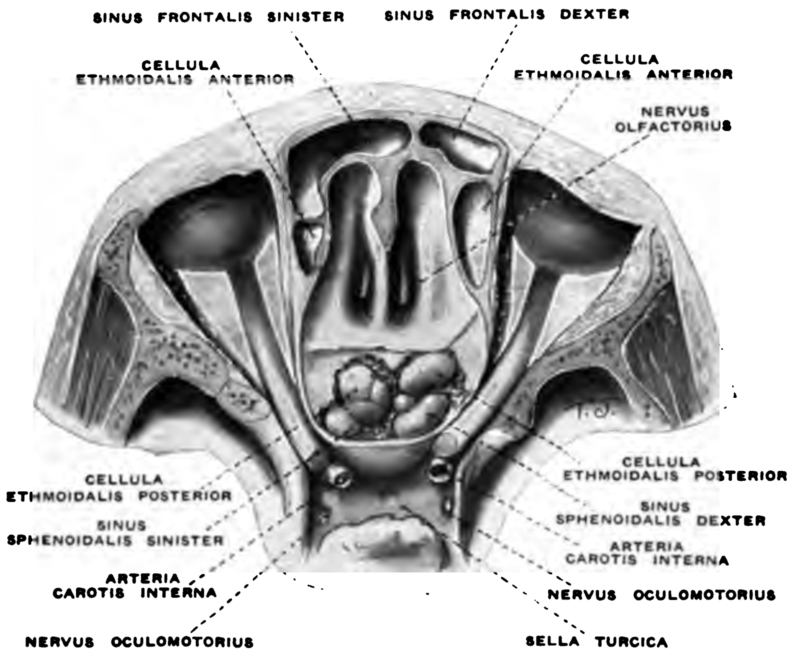


Fig. 44. (Head IX.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

The optic chiasm in these heads is in the main in relation with one or both sphenoid sinuses. It is directly upon the roof in heads VI (Fig. 41) both sides; VII (Fig. 42); XII (Fig. 47) both sides; XIII (Fig. 48) left;

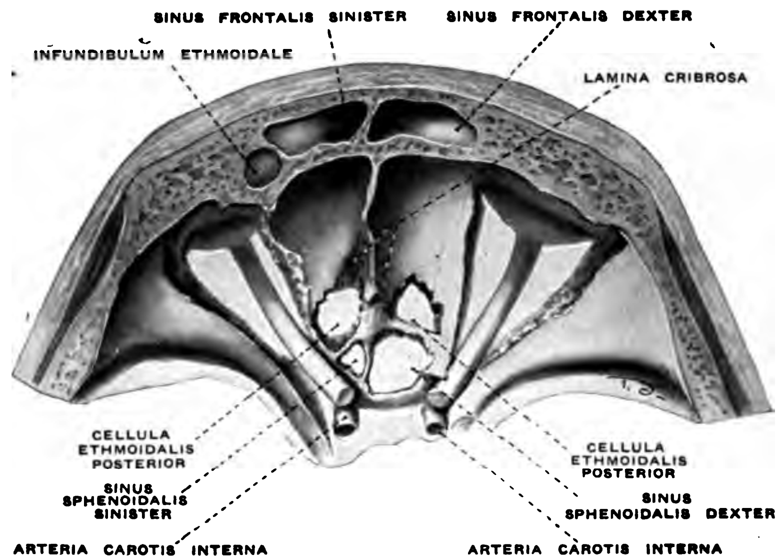


Fig. 45. (Head X.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

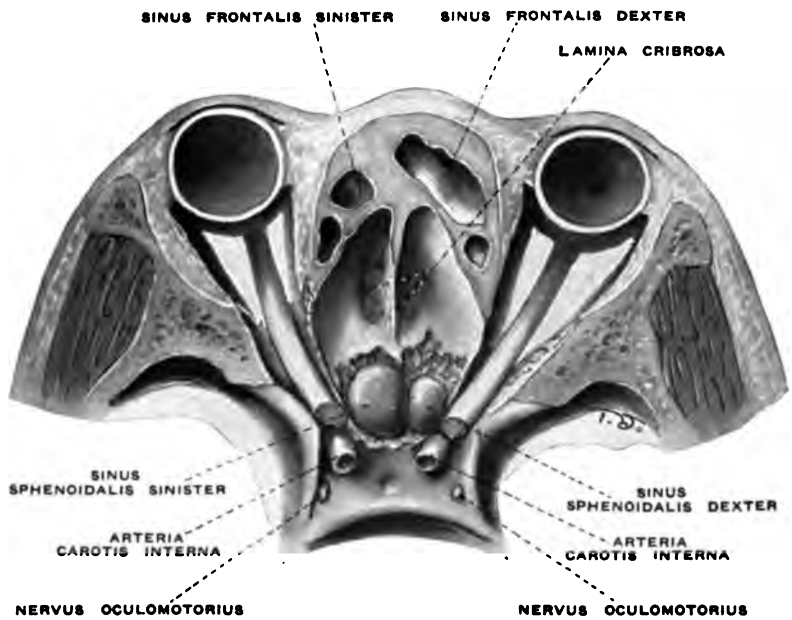


Fig. 46. (Head XI.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

XV (Fig. 50) left; XVII (Fig. 52) right; XVIII (Fig. 53) left; XIX (Fig. 54) both sides.

It lies considerably above the roof in VIII (Fig. 43) left; XIV (Fig. 49) left; XVI (Fig. 51) left.

It lies posterior to the sphenoid sinus in VIII (Fig. 43) both sides; IX (Fig. 44) both sides; X (Fig. 45) both sides; XI (Fig. 46) both sides; XIII (Fig. 48) right; XIV (Fig. 49) both sides; XVI (Fig. 51) both sides; XVII (Fig. 52) left; XX (Fig. 55) both sides.

It is thus seen that in more than half of the instances the chiasm lies posterior to the sphenoid cavity. Special attention is called to VI, VII, XII, XIII, XVII, XIX, where a considerable portion of the sphenoid cavity lies beyond the anterior margin of the optic chiasm. No other cells among these specimens come into relation with the optic chiasm.

The optic nerve may be described as passing externally from the chiasm along the roof or lateral wall of the sphenoid sinus in slight relation, usually with the last posterior ethmoid cell, and from thence to the bulbus opticus through the periorbita.

It may be divided into a sinus portion and a free portion. Under the former term, I include that part of the nerve in immediate relation with the accessory cavities of the nose or (arbitrarily) within 3 mm. of the sinus wall.

The following measurements show the length of the nerve in the different heads:

LENGTH OF OPTIC NERVE
(In Millimeters)

HEAD			FREE PORTION		SINUS PORTION	
	R.	L.	R.	L.	R.	L.
VI.	44	44	21	22	23	22
VII.	54	55	22	24	32	31
VIII.	40	40	21	20	19	20
IX.	45	45	18	20	27	25
X.	37	34	18	15	19	19
XI.	54	55	26	26	28	29
XII.	45	44	22	23	23	21
XIII.	39	40	15	12	24	28
XIV.	43	40	15	14	28	26
XV.	54	47	28	27	26	20
XVI.	43	44	19	18	24	26
XVII.	40	40	19	23	21	17
XVIII.	48	45	23	20	25	25
XIX.	39	37	15	14	24	23
XX.	44	44	21	23	23	21

The following variations are obtained:

Optic nerve: range, 34 to 55; usual, leaving off highest and lowest five, 40 to 48; average 44.

Free portions: range, 12 to 38; usual, leaving off highest and lowest five, 15 to 23; average 20.

Sinus portion: range, 17 to 32; usual, leaving off highest and lowest five, 21 to 28; average 24.

It is therefore clear that, at least in these heads, the sinus portion of the optic nerve is a trifle greater than the free portion.

There does not appear to be any correspondence between the length of the optic nerve and the extent of accessory cavities.

Where the sinus is very large, the optic nerve has its origin in the chiasm on the roof of the sphenoid, some distance anterior to the posterior wall of the sinus, as for instance in VI (Fig. 41) right; VII (Fig. 42) both sides; XII (Fig. 47) left; XIII (Fig. 48) both sides; XX (Fig. 55) both sides.

Where the sinus is small, the optic nerve leaves the chiasm generally behind the sinus, as seen in VIII (Fig. 43); IX (Fig. 44) both sides; X (Fig. 45) both sides; XVI (Fig. 51) both sides. Head XVIII (Fig. 53) is somewhat at variance with this rule, but, under any circumstances, it does not appear possible to assign the variation of the sinus as an explanation for the varying size of the optic nerve, nor for the relation which the sphenoid opening bears to the optic nerve.

The following table of measurements shows this difference.

DISTANCE BETWEEN LOWER SURFACE OF OPTIC NERVE AND NASAL OPENING OF SPHENOID

(In Millimeters)

HEAD	RIGHT	LEFT
VI.	9	6
VII.	6	6
VIII.	2	6
IX.	6	7
X.	3	2
XI.	9	12
XII.	9	3
XIII.	5	0
XIV.	14	14
XV.	8	5
XVI.	12	11
XVII.	5	5
XVIII.	1 above	2 above
XIX.	1 above	1
XX.	8	12

Range, 2 above to 14; usual, leaving off highest and lowest five, 2 below and 11; average 6.

In two instances XVIII (Fig. 53) both sides, and XIX (Fig. 54) right,

the orifice is above the lower surface of the optic, and in XIII (Fig. 48) left, it reaches the same level. In nine instances out of the thirty, the

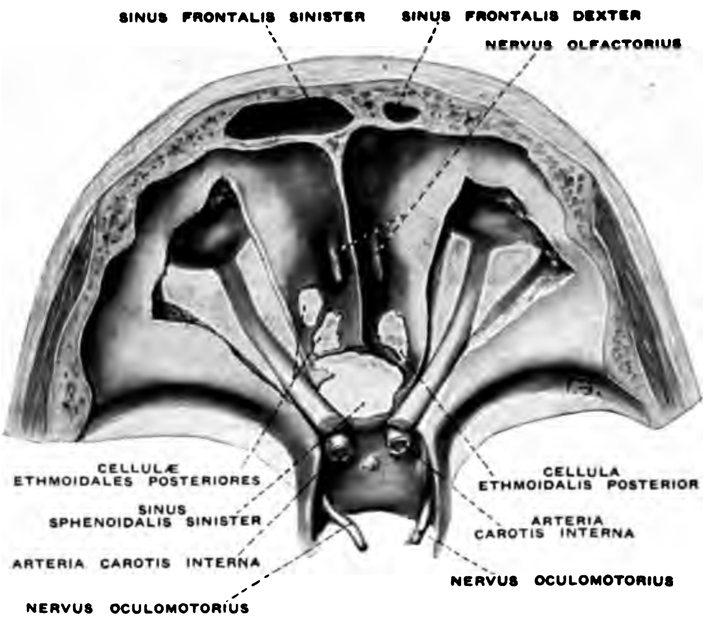


Fig. 47. (Head XII.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

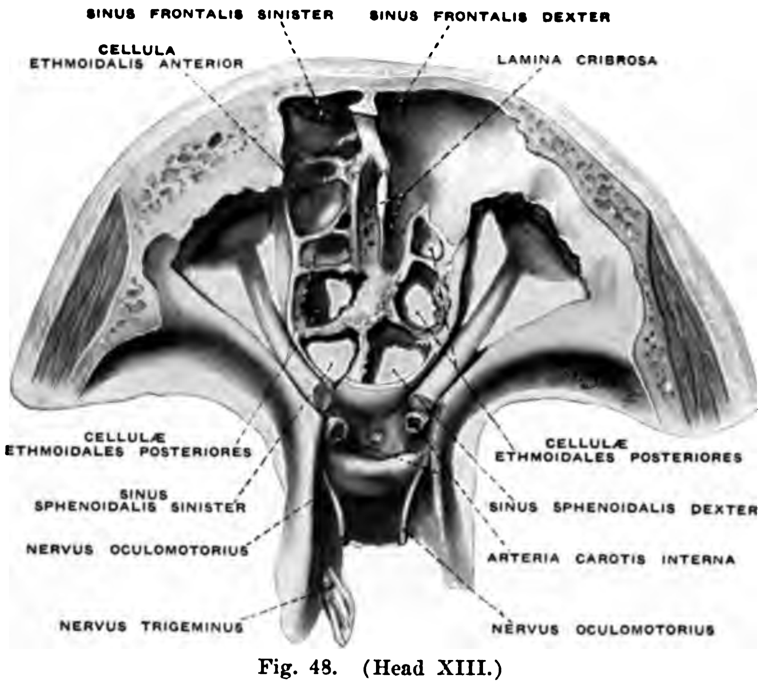


Fig. 48. (Head XIII.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

optic nerve lies within 3 mm. of the level of the orifice of the sinus. When the optic nerve lies so near the level of the orifice of the sphe-

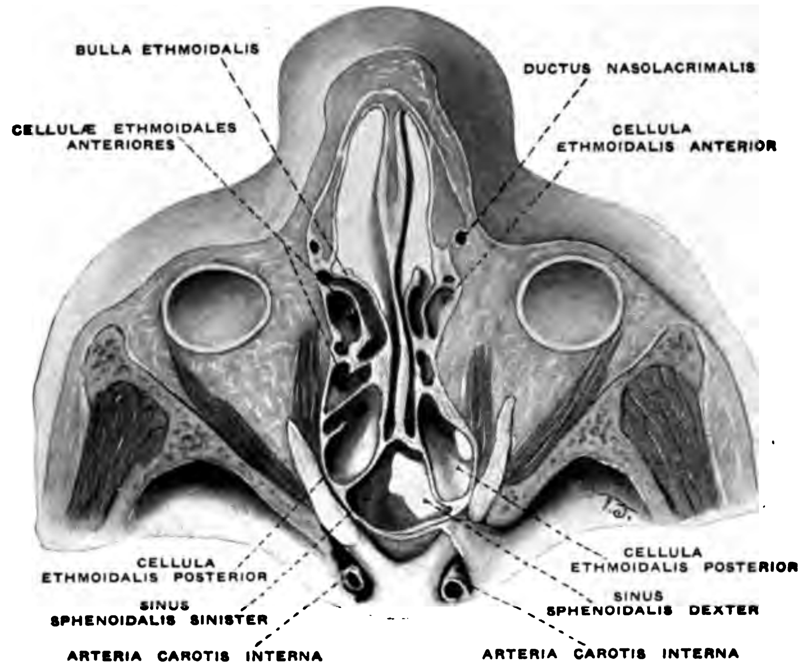


Fig. 49. (Head XIV.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

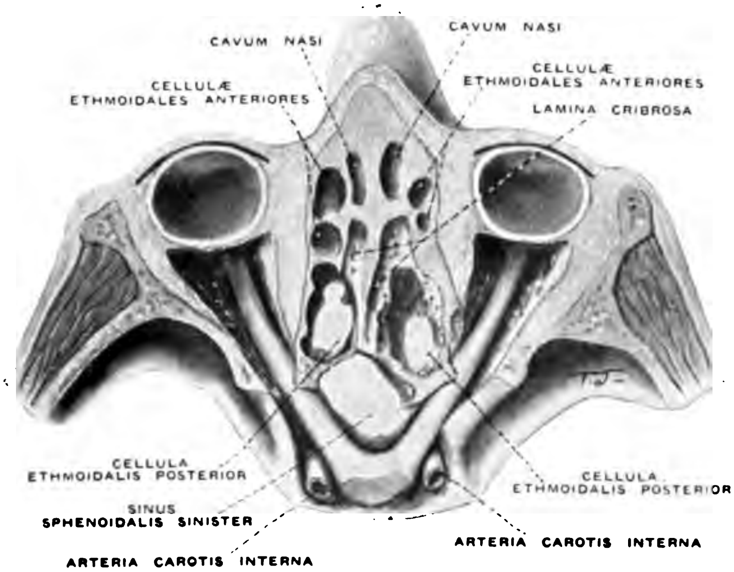


Fig. 50. (Head XV.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

noid, it is in a far more vulnerable position than when its distance is greater, for the orifice represents the possible height of pus in sphenoid empyema with an open orifice.

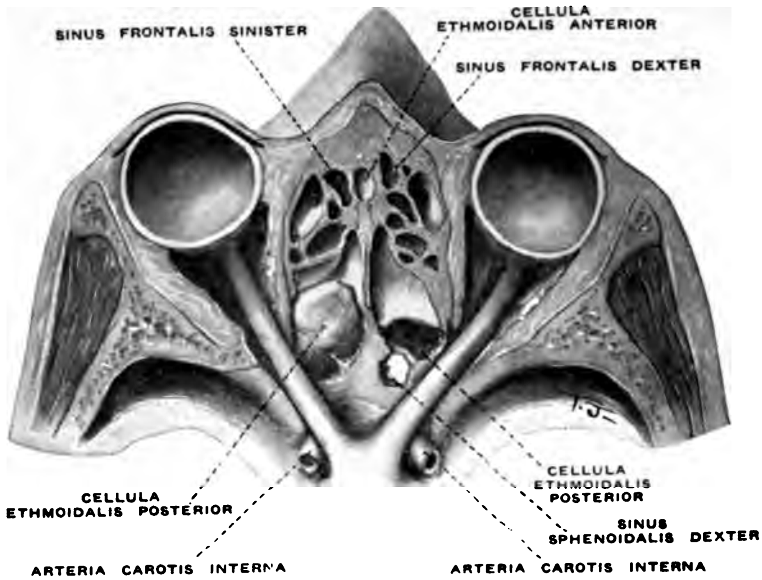


Fig. 51. (Head XVI.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

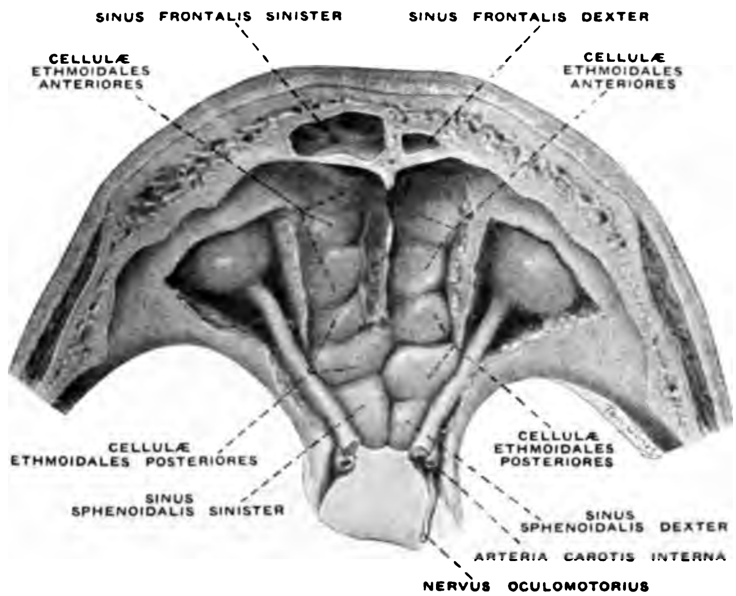


Fig. 52. (Head XVII.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

The optic nerve as a rule comes into relation with the postero-external angle of the last posterior ethmoid cell at its roof, and from this point it passes in an external direction through the periorbita to

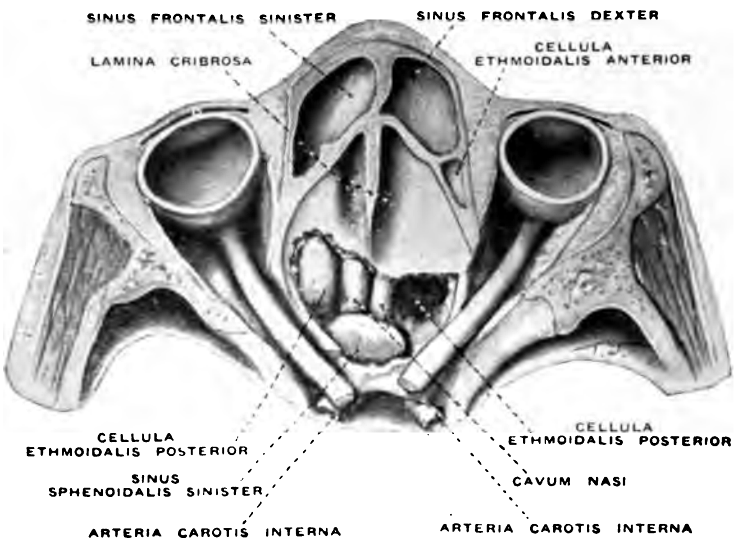


Fig. 53. (Head XVIII.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

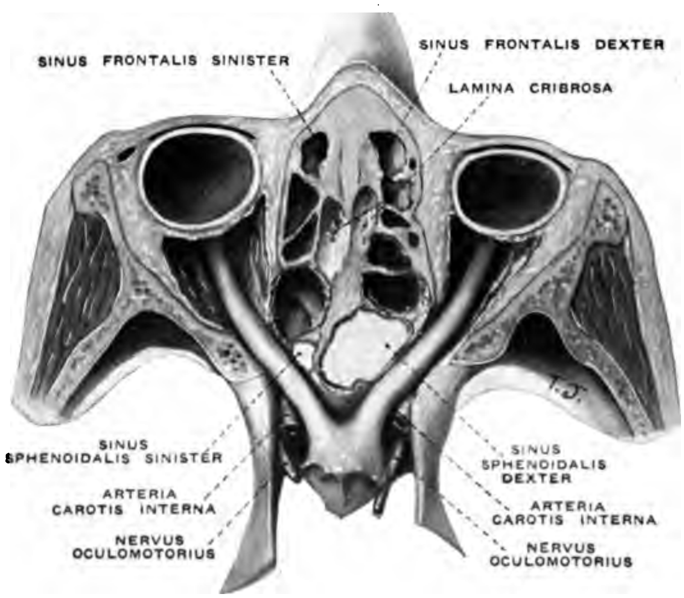


Fig. 54. (Head XIX.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

the bulbus. The space between the nerve and the ethmoid labyrinth increases in almost direct proportion as the nerve approaches the bulbus, and its junction with the bulbus is generally the position of greatest distance between the nerve and the ethmoid labyrinth.

In only one case, XII (Fig. 47) does the anterior ethmoidal cell come in close relation with the optic nerve, replacing a posterior ethmoid cell which lies below it. The relation which the nerve bears to the last posterior ethmoid, when that cell replaces the sphenoid,

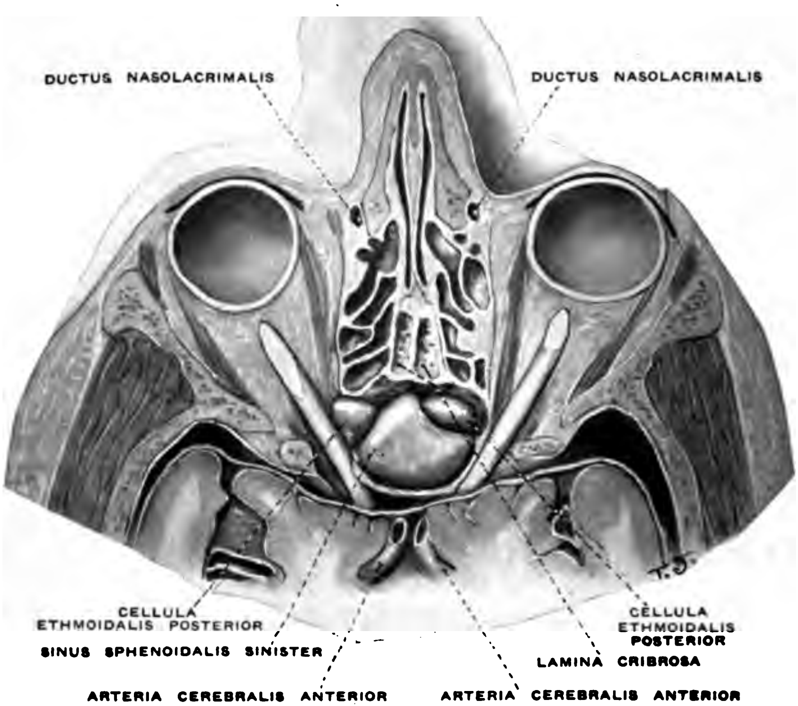


Fig. 55. (Head XX.)
Preparation showing relation of optic nerve to accessory sinuses of the nose.

is very characteristic, for in the two instances in which this replacement is present in the heads examined, XVI (Fig. 51) and XVIII (Fig. 53), the nerve is found to run along the external wall of the cavity. This increases the ethmoid portion very considerably, changing it from a course along an angle to one along a wall which it follows in an almost surprising manner. This probably explains the cases of optic neuritis which complicate an ethmoiditis without an accompanying sphenoiditis, as in the writer's case of blindness cured by ethmoid exenteration.

The frontal sinus is relatively distant from the optic nerve, the nearest point being, as a rule, at the inner side of the orbit, and here it is much further away than the corresponding anterior ethmoid cells, which ordinarily lie anterior to it at the level of the optic nerve. In some instances, however, the frontal sinus may extend for a considerable distance backward; for example VII, X, XI, XII, XV, XVII, XVIII, XX. In all the cases the sinus is much closer to the optic nerve than where the sinus remains anterior.

In all the specimens the periorbital fat makes a close relation with the maxillary sinus impossible, although, in some instances, the distance is less than 10 mm.

Nasolacrimal Duct.

The increasing disposition to treat stenosis of the nasolacrimal duct by operation through the nose justifies a study of its topographic

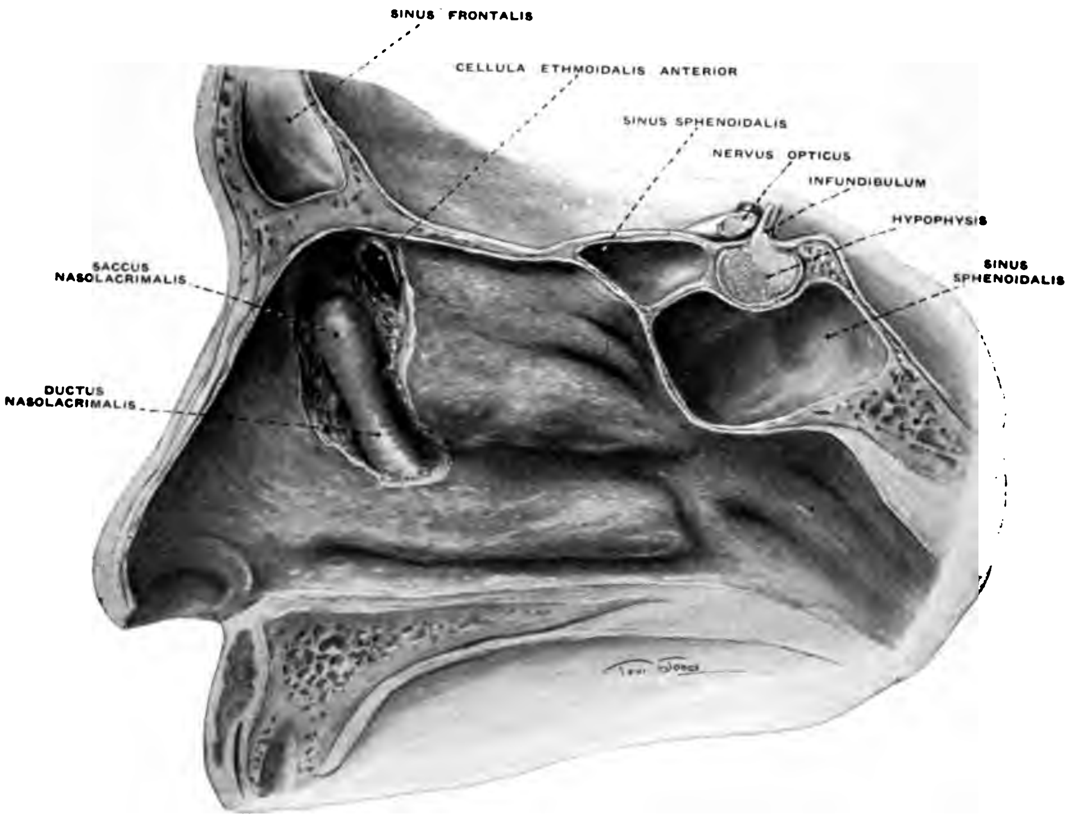


Fig. 56.

Right lateral wall of the nose with exposure of the saccus nasolacrimalis and ductus nasolacrimalis.

relations in the nose. The superior and inferior canaliculæ lacrimales, which start at the puncta lacrimalis, convey the tears into an expanded pouch called the saccus lacrimalis closed above and being continuous below with the ductus nasolacrimalis which itself opens just below the maxillary attachment of the concha inferior.

The saccus lacrimalis lies in the fossa lacrimalis between the crista lacrimalis anterior and the crista lacrimalis posterior (Figs. 9,

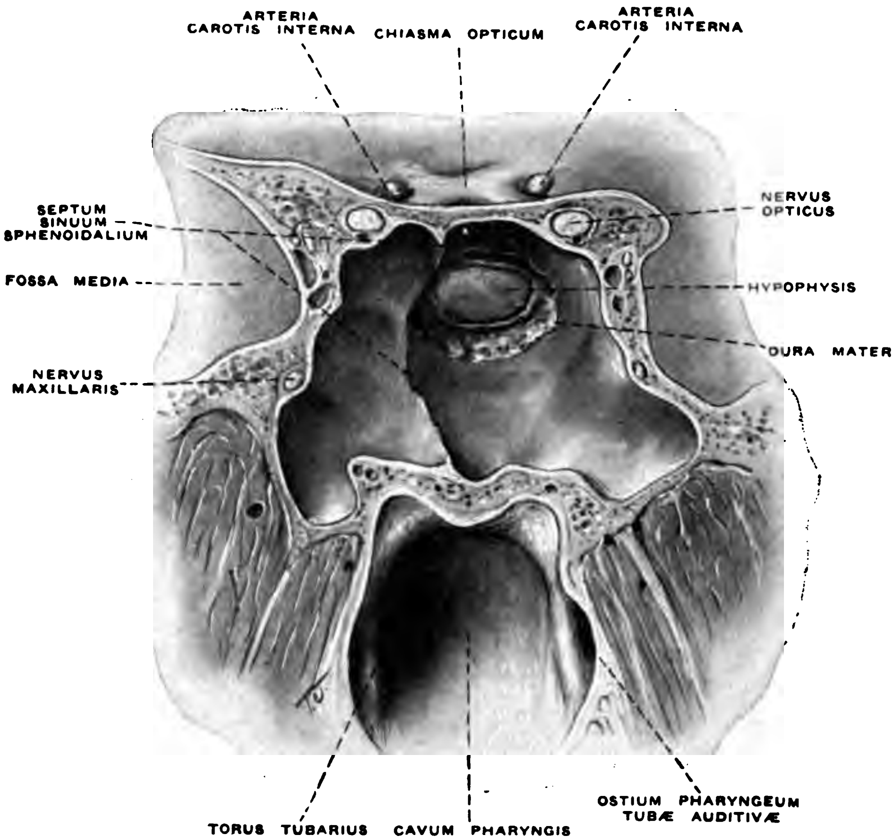


Fig. 57.
Coronal section through the sphenoid sinuses, removal of septum sinuum sphenoidalium and exposure of the hypophysis by cutting away the bone of the posterior wall of the left sphenoid sinus.

11). It extends to the canal (canalis nasolacrimalis) and merges into the ductus nasolacrimalis which runs between the lateral wall of the nose and the maxillary sinus.

The illustration (Fig. 56) shows the course of the sac (the upper expanded portion) and the duct along the external wall of the nose. In the specimen, the bone of the external wall has been cut away

leaving the sac and the duct free as far as its opening below the inferior turbinate. It is to be observed that they lie anterior to the middle turbinate and anterior and inferior to the first ethmoid cell which is here exposed.

Hypophysis (Pituitary Body).

The location of the pituitary body or hypophysis behind the sphenoid sinuses, makes it a factor in intranasal surgery. It lies in the fossa hypophyseos of the sphenoid bone (Fig. 56). It consists of an anterior grey portion, ectodermic in origin, and a posterior white portion, epidermic in origin, connected by the infundibulum with the third ventricle. A reflection of the dura, diaphragma sellæ, which stretches from the anterior to the posterior clinoid processes separates the hypophysis from the optic chiasm and optic tracts, which lie just above it. The infundibulum penetrates the dura behind the optic chiasm and between the right and left optic tracts. Laterally the cavernous sinus surrounding the internal carotid artery comes into relation with the pituitary body and the adjacent structures. Anteriorly and inferiorly it comes into relation with the sphenoidal sinus, as shown in Figs. 12 and 56. Figure 57 is an illustration of a preparation made by cutting away that part of the roof of the sphenoid sinus forming the hypophyseal fossa and the dural investment, leaving the pituitary body free in the cavity. The septum between the two sinuses has also been removed. The specimen shows how the hypophysis may be safely exposed by an endonasal operation through the sphenoid sinuses.

Vascular Supply.

Arteries.—The arteries of the external nose have their origin mainly from the arteria maxillaris externa. Branches of the arteria ophthalmica and arteria septi communicate with the network from the arteria maxillaris externa. The frontal region is supplied by the arteria ophthalmica, the arteria frontalis and the arteria supraorbitalis.

The nasal cavities and the accessory cavities are supplied by the branches of the arteria ophthalmica, arteria maxillaris interna and the arteria maxillaris externa.

The arteria sphenopalatina, terminal branch of the arteria maxillaris interna passes from the fossa pterygopalatina through the foramen sphenopalatinum into the nasal cavity, giving off the arteriæ nasales posteriores and the arteriæ nasales posteriores septi (nasopalatine).

The branches of these vessels supply the inferior, middle and

superior turbinates, the mucosa of the inferior and middle meatus, the sphenoid sinus, and also a portion of the septum.

The arteria ethmoidalis anterior and the arteria ethmoidale posterior leave the orbit through the foramen ethmoidalis anterius and the foramen ethmoidale posterius respectively, enter the cranial cavity passing under the dura and perforate into the nose through the lamina cribrosa supplying the ethmoid cells, and the upper portion of the lateral nasal wall and septum.

The arteria alveolaris superior, and arteria alveolaris posterior and the arteria infraorbitalis supply the mucosa of the maxillary sinus and the periosteum of the maxilla.

Veins.—The venus network of the external nose is connected with that of the vena facialis anterior and vena ophthalmica, the following veins collecting the supply, vena nasofrontalis and vena angularis.

The veins of the nasal cavities and the accessory cavities are connected with those of the nasopharynx, eye, dura, while those of the mucosa of the concha are connected with the plexus cavernosus in addition.

The venous supply in this region is collected by the vena ethmoidalis anterior and the vena ethmoidalis posterior which enter the vena ophthalmica superior and the vena ophthalmica inferior.

Innervation.

The nervus olfactorius sends its filaments (fila olfactoria) about twenty in number, through the lamina cribrosa and they supply the mucosa of the superior and middle upper part of the turbinate and the septum in the corresponding position.

The first and second branches of the nervus trigeminus supply the nasal mucosa. The nervus ethmoidalis anterior and nervus ethmoidalis posterior originate from the first, and the nervus sphenopalatinus and nervus infraorbital from the second.

The nervus ethmoidalis posterior which is accompanied by a small branch from the sphenopalatine supplies the mucosa of the sphenoid sinus and posterior ethmoid cells. The nervus ethmoidalis anterior has three branches, the ramus septi supplying the upper portion of the mucosa of the septum, the ramus lateralis, the middle turbinate and anterior portion of the inferior turbinate and posterolateral wall of the nose and the ramus anterior to that of the anterior portion of the roof.

The nervus infraorbitalis gives off the nervi alveolares superiores which supply the mucosa of the maxillary sinus and anterior part of the floor of the nose. The ganglion sphenopalatinum gives off the nervi

nasales which supply the upper and posterior portion of the lateral wall of the nose, the mucosa of the superior meatus, and the superior and middle turbinates and ethmoid cells.

The nervi nasopalatini are branches of the ganglion sphenopalatinum which supply the posterosuperior portion of the septum. The nervus nasopalatinus is the largest branch of the sphenopalatine. It passes down the septum to the canalis incisivus and supplies the adjacent portions of the septum.

The nervus ethmoidalis anterior supplies the mucosa of the anterior ethmoid cells and frontal sinus; the nervi alveolares superiores the maxillary sinus; the nervus ethmoidalis posterior and the nervi nasales the posterior ethmoid cells; and the nervi nasales the sphenoid sinus.

Sympathetic System.—Fibres from the plexus caraticus pass through the ganglion sphenopalatinum which gives off fibres which are distributed to the posterior two-thirds of the inferior and middle turbinate and nasal septum.

CHAPTER II.

SURGICAL ANATOMY OF THE PHARYNX, LARYNX, AND NECK.

BY GEORGE B. WOOD, M.D.

THE PHARYNX.

The pharynx, which is a funnel-shaped tube, is divided for convenience of description into three portions, the nasopharynx, oropharynx and the laryngopharynx. During quiet inspiration with the mouth closed it presents anteriorly in order from above downward the posterior nares or choanæ, the soft palate with its anterior pillars attached to the tongue and its posterior pillars to the lateral wall of the pharynx, the epiglottis (the tip of which is almost in contact with the uvula), the laryngeal opening, the posterior surface of the arytenoid bodies, and on each side of these, the pyriform sinuses. Each lateral wall presents the Eustachian prominence with the opening of the Eustachian tube, posterior to this the fossa of Rosenmüller and below, the lateral folds of the pharynx. The posterior wall is a smooth surface showing small deposits of lymphoid tissue and is continuous above with the vault, which arches forward to the upper part of the choanæ. In the vault is situated the large mass of lymphoid tissue which is designated the pharyngeal tonsil. The pharynx is greater in its lateral than in its anteroposterior diameter, the greatest breadth being just above the soft palate.

The Nasopharynx.

The nasopharynx extending from the vault to the lower border of the soft palate is an open cavity, the lateral, superior and posterior walls of which are rigid. The choanæ or posterior nares are two oblong spaces taking the place of practically the whole of the anterior wall. The vault or fornix of the pharynx forms the roof of the cavity and is occupied in part by the pharyngeal tonsil.

The **Pharyngeal Tonsil**, composed of lymphoid tissue, varies extremely in size and shape. It may consist simply of a few small elevations scarcely noticeable to the naked eye, or it may be a large pendant mass filling the greater part of the nasopharyngeal cavity. In shape

it may be a more or less distinct rounded elevation, placed directly in the middle of the vault just behind the upper level of the choanæ and the upper part of the nasal septum, or it may be diffused, spreading from the vault out into the fossa of Rosenmüller, downward on the posterior pharyngeal wall, and latterly to the lateral folds.

On each side of the pharyngeal tonsil, and at about the level of the posterior end of the inferior turbinal is the pharyngeal orifice of

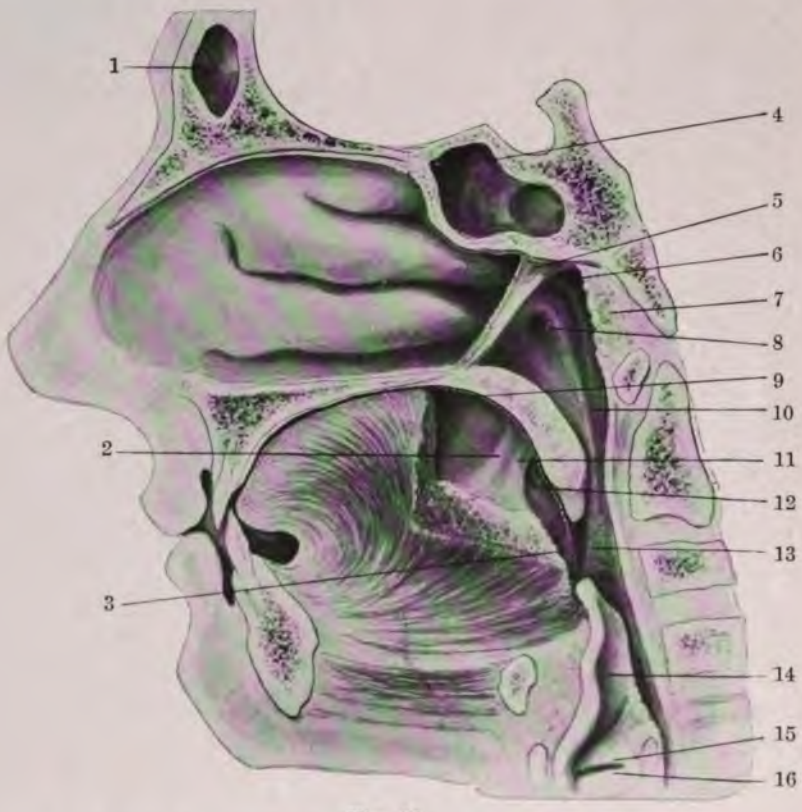


Fig. 58.

Median section through face of an adult man, showing the normal relations of the structures during quiet nasal respiration.

1, Frontal sinus; 2, Anterior palatal pillar; 3, Posterior palatal pillar; 4, Sphenoid sinus; 5, Posterior edge of nasal septum; 6, Fossa of Rosenmüller; 7, Pharyngeal tonsil; 8, Ostium of Eustachian tube; 9, Dotted line showing contour of the tongue; 10, Salpingopharyngeal fold; 11, Plica triangularis; 12, Palatal tonsil; 13, Lateral pharyngeal fold; 14, Epiglottis; 15, Ventricular band; 16, Vocal cord.

the Eustachian tube. The opening is quite large, funnel-shaped, with a small end of the funnel directed towards the tympanum. Above and behind the opening is the Eustachian prominence, consisting of a rounded ridge formed by the projection of the Eustachian cartilage.

The anterior margin of the opening is much less prominent than the posterior and this fact helps greatly in the introduction of the Eustachian catheter. Extending downward from the posterior margin of the Eustachian tube is a fold of mucous membrane, the salpingopharyngeal fold, which is gradually lost in the lateral wall of the pharynx, or it may be continuous with the lateral pharyngeal fold. A somewhat similar ridge, but much less marked, is the salpingopalatine fold which runs from the anterior border of the Eustachian orifice downward and forward to the palate. Contraction of the levator palati

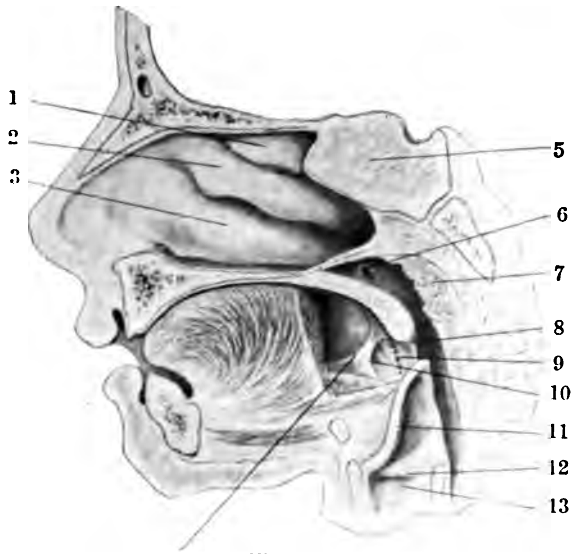


Fig. 59.

Median section through the face of an infant one month old, showing the relations of the structures during quiet nasal respiration.

1, Superior turbinate; 2, Middle turbinate; 3, Inferior turbinate; 4, Anterior palatal pillar; 5, Body of sphenoid bone; 6, Eustachian tube; 7, Pharyngeal tonsil; 8, Posterior palatal pillar; 9, Dotted line showing contour of the tongue; 10, Plica triangularis; 11, Epiglottis; 12, Ventricular band; 13, Vocal cord.

muscle produces an elevation known as the levator cushion which presses to a greater or less extent against the lower border of the Eustachian orifice. Behind the Eustachian prominence is a wedge-shaped depression called the fossa of Rosenmüller, or the lateral recess of the pharynx. This depression gradually disappears on the lateral wall of the pharynx at about the level of the soft palate. It tends to accentuate the Eustachian prominence and the salpingopharyngeal fold. In the middle of the vault of the pharynx is a sinus running up behind the pharyngeal tonsil. This sinus is called the bursa pharyngea, and is supposed by some to be the remnant of the lower portion of the

pouch of Rathke. It is, however, simply an occlusion sinus formed by the adhesion of folds of the pharyngeal tonsil.

The vault of the pharynx receives its blood supply chiefly from the pharyngeal branch of the vidian artery. The branches of this artery anastomose with the ascending pharyngeal, and the pharyngeal branch of the pterygopalatine. The pterygopalatine is a branch of the internal maxillary, while the ascending pharyngeal comes directly from the external carotid. The veins follow roughly the course of their corresponding arteries and open into the pterygoid plexus which is situated partly on the inner surface of the internal pterygoid muscle, and

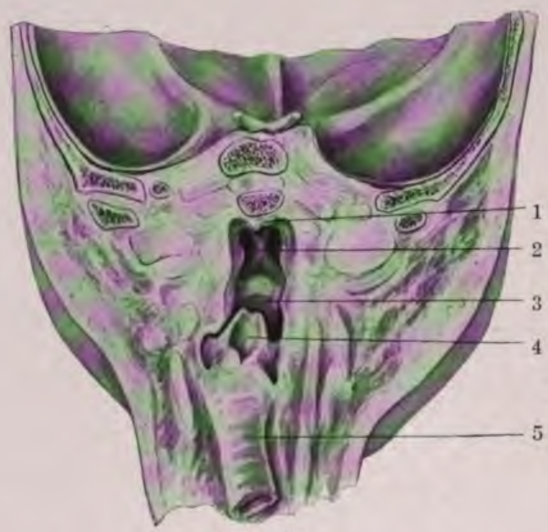


Fig. 60.

Transverse section through the head of a child one month old, just in front of the posterior pharyngeal wall. The neck has been twisted so that the larynx is thrown somewhat to the left. Illustration shows the relation of the epiglottis to the uvula.

1, Pharyngeal tonsil; 2, Nasal septum; 3, Uvula; 4, Epiglottis; 5, Trachea.

partly around the external pterygoid muscle. The pterygoid plexus empties posteriorly into the internal maxillary vein and anteriorly into the deep facial vein.

The lymphatic drainage of the vault of the pharynx is through a rather close mesh of lymph vessels, which drain either into the retropharyngeal lymph gland, or into the posterior or external group of the deep lateral chain, the vessels passing posteriorly to the large vessels of the neck, and behind the rectus capitis anticus muscle.

The nerve supply of the pharyngeal vault is derived from the pharyngeal branches of Meckel's ganglion.

The Oropharynx.

The division between the nasopharynx and oropharynx is a very movable one consisting of the free edge of the soft palate. The upper surface of the soft palate forms an anteroinferior wall to the nasopharynx, while the inferior surface is directed towards the mouth. In the infant the lower border of the soft palate reaches almost to the epiglottis, but in the adult there is more space between the epiglottis and the palate which is filled in by the dorsum of the tongue. The anterior wall of the oropharynx is, therefore, made up of the uvula, pharyngeal portion of the dorsum of the tongue and the epiglottis. The lateral diameter is about twice the anteroposterior diameter, but both of these distances are constantly changing, according to the action of the palatal and pharyngeal muscles. The lateral wall of the oropharynx generally presents a more or less marked perpendicular ridge of lymphoid tissue, sometimes spoken of as the lateral pharyngeal fold.

Palatal or Faucial Tonsil.—The palatal tonsil, more generally spoken of as the faucial but less correctly so, is situated in a fossa between the anterior and posterior palatal or faucial pillars. Both in size and shape, the tonsil varies extraordinarily. To understand this variation we must study the development of the organ. Probably the first recognizable sign of the faucial tonsil is to be found in the embryo at four months. At five months there is a distinct vertical groove about 2 mm. in height, at the bottom of which a small mass of adenoid tissue has already developed and in this mass minute slit-like impressions can be found. In the embryo at eight months the form of the tonsil is fairly constant. At this time the tonsil does not project beyond the surface and is covered anteriorly by a fold called the plica triangularis or operculum. This fold divides a little above its middle into two distinct branches, one running anteriorly to the tongue forming a fold called the plica pretonsillaris, and another running posteriorly passing round the base of the tonsil anlage called the plica infratonsillaris. The space bounded by these two folds above, and by the tongue below, is called the fossa triangularis. The upper part of the plica triangularis is continued above the tonsil until it meets the posterior pillar of the fauces and in this position is called the plica supratonsillaris. At this time the tonsillar mass is irregularly divided into three lobes by two fissures, running from below and behind upward and forward. The lower and middle are merged into one another in front and the upper and middle less distinctly so behind. At the junction of the two lower the plica triangularis becomes adherent to the tonsillar mass, and in this way a recess

is formed above and slightly to the front of the superior convolution which later develops into the supratonsillar fossa. In the majority of children at birth this typical condition can be recognized only with difficulty, as the tonsil is already beginning to take on the irregularity of growth which is one of its characteristic features. After birth the development of the tonsil is very irregular, and its final shape and size depend upon the position and amount of adenoid tissue present. In

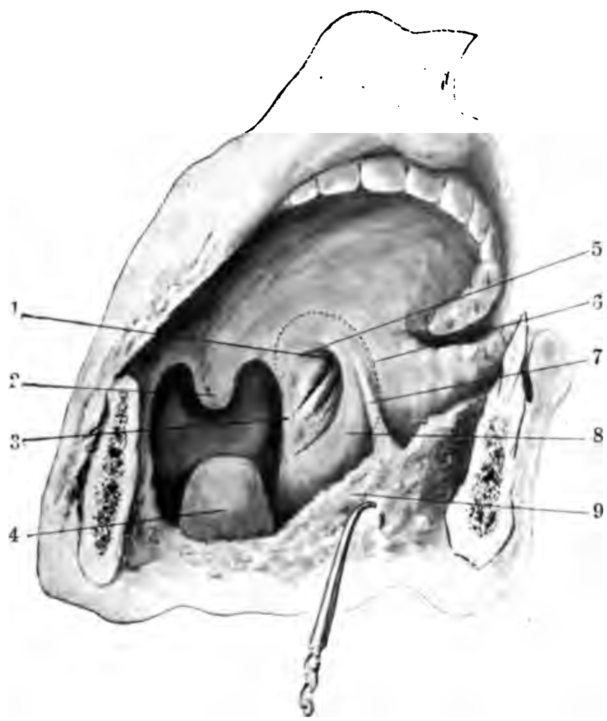


Fig. 61.
The region of the palatal tonsil.
1, Supratonsillar fossa; 2, Uvula; 3, Posterior palatal pillar; 4, Epiglottis; 5, Plica supratonsillaris; 6, Dotted line showing the subsurface extent of the tonsil; 7, Anterior palatal pillar made prominent by traction on the tongue; 8, Plica triangularis; 9, Cut surface of tongue, traction being made downward.

the majority of cases the greatest amount of development takes place in the lower two lobes. These by their growth project outward and finally hide from view the superior lobe which can be found only by looking deep into the supratonsillar fossa. If the adenoid tissue develops in the supratonsillar margin, a distinct tonsillar mass will be found in the palate, and its growth downward leaves a fistulous tract running upward from the hilum of the tonsil. The plica triangularis

may remain rudimentary in which case it can scarcely be seen, or it may develop so as to cover to a greater or less extent the anterior portion of the tonsillar mass. In those cases in which the development involves chiefly the superior lobe the supratonsillar fossa becomes almost obliterated. The vagaries of the growth of adenoid tissue in the various parts of the tonsil determine the shape and size of the tonsillar mass.

The tonsil is separated from the surrounding structures by a distinct fibrous capsule. This capsule surrounds the tonsil on all sides except the mesial free surface. At the front it runs inward beneath the plica triangularis over the surface of the tonsil almost to the line where the plica merges into the tonsillar mass. Behind it terminates at the free edge of the posterior pillars, above it reaches to the supratonsillar margin, but below it does not come quite to the surface epithelium, as there is very apt to be a thick lymphoid deposit just below the tonsil. The capsule sends strong fibrous trabeculæ into the substance of the tonsil which carry the blood vessels, lymphatics and nerves. An important peculiarity of the operculum or plica triangularis is that in the fully developed tonsil it is attached firmly to the tonsillar mass only close to its very edge, and can be readily separated from the capsule which covers the front of the tonsil.

The crypts are ingrowths of the surface epithelium, their lumina being formed by the desquamation of a central core. These crypts vary both in number and in size but they generally run deep into the adenoid mass, terminating usually close to the capsule, and they may communicate more or less with each other. They are as a rule larger and more numerous in the upper part of the tonsil. In the usual type of tonsil the growth of the two lower lobes forms a deep pocket close to the capsule, with its opening in the supratonsillar fossa. This pocket is not in the true sense of the word a crypt, but is rather an inclusion recess similar to that which forms in the palate from overgrowth of the supratonsillar margin.

The tonsil is surrounded externally by the pharyngeal aponeurosis which is rather loosely associated with the capsule. External to this is the superior constrictor muscle of the pharynx. Still further externally is the buccopharyngeal fascia, a thin and in places ill defined layer which surrounds the constrictors of the pharynx and the outer surface of the buccinator muscle. Immediately beyond this rather thin covering, the tonsil is in relation with a space filled with loose fatty areolar tissue. The outer wall of this space is formed by the internal pterygoid muscle; its posterior wall by the prevertebral muscles and the internal wall by the pharynx. This triangular space

is irregularly divided into two smaller spaces by the stylopharyngeus muscle, and external to this by the styloglossus muscle. The faucial tonsil is in relation with the anterior of these two divisions, while the internal carotid artery is placed well back in the posterior division. The internal carotid is never closer than 1.5 cm. from the wall and the pharynx is more or less separated from it by the interposition of the stylopharyngeus muscle. The external carotid artery lies about 2 cm. from the lateral wall of the pharynx, and has interposed between it and the tonsil a portion of the parotid gland, and the whole of the

Fig. 62.
Dissection of the region of the palatal tonsil from the outside.
1, Capsule of palatal tonsil; 2, Facial artery; 3, Hypoglossal nerve; 4, Superior thyroid artery; 5, Tonsillar branch of facial artery; 6, Occipital artery; 7, Internal carotid artery; 8, Lingual artery; 9, External carotid artery; 10, Spinal accessory nerve; 11, Common carotid artery; 12, Descendens hypoglossi nerve; 13, Pneumogastric nerve.

musculature of the styloid process. It must be remembered, however, that the outer surface of an enlarged and embedded tonsil is not in the same plane as the pharyngeal wall, and it thus may come in much closer relation to the large blood vessels in the neck than the above description would lead one to suppose. Furthermore, the facial artery quite frequently, after branching from the external carotid, has a decided upward bend before it sweeps outward to pass around the ramus of the jaw. When this upper bending is marked, the loop of the artery thus formed comes in close relation to the inferior portion of the ton-

sil, making it possible to wound this artery during operations on the tonsils. The only muscle intervening between it and the tonsil is the superior constrictor. The two carotid arteries, however, are separated from the tonsil by the stylopharyngeus and the styloglossus.

The blood supply of the tonsil comes chiefly through the tonsillar branch of the facial artery. The lower part of the tonsil, however, may be supplied from a branch of the lingual, sometimes coming from the dorsalis linguæ, and sometimes from the main lingual trunk. Occasionally the palatine branch of the ascending pharyngeal supplies the posterior upper part. The internal maxillary also contributes to the blood supply of the tonsil through a small branch coming from the posterior or descending palatine. The division from the facial generally breaks up into two or three branches which penetrate the capsule and which again break up into numerous branches before entering the tonsil with the trabeculæ. Sometimes almost a plexus of arteries is formed in the outer layers of the capsule by the anastomoses of the supplying blood vessels.

The nerve supply of the tonsil is through a special branch of the glossopharyngeal, which, uniting with branches from the pharyngeal plexus forms what might be called a small tonsillar plexus.

Pillars and Lateral and Posterior Walls.—The anterior palatal pillar or anterior pillar of the fauces is a fold caused by the prominence of the palatoglossal muscle, while the posterior palatal pillar, or posterior pillar of the fauces, is formed by the palatopharyngeal muscle. Behind the posterior palatal pillars on each side of the pharynx is found a more or less well-marked mass of lymphoid tissue, longitudinal in shape, generally spoken of as the lateral fold of the pharynx. This longitudinal elevation appears to be a continuance downward of the salpingopharyngeal fold, its prominence, however, is due not to a prominent muscle but to the lymphoid tissue, which according to Cortes at times resembles the structures of the faucial tonsil, possessing crypts and other of its peculiar histologic characteristics. On the posterior pharyngeal wall we find a varying number of isolated patches of lymphoid tissue, spoken of as lymphoid follicles. These small lymphoid structures are more numerous in the upper part of the throat, and seem to be an irregular downward extension of the pharyngeal tonsil.

The Laryngopharynx.

The laryngeal portion of the pharynx, or the laryngopharynx, extends from the epiglottis down behind the larynx to the level of the sixth cervical vertebra. This corresponds about to the lower border

of the cricoid cartilage. Below the arytenoid cartilages the walls of the laryngopharynx are in apposition except during the act of swallowing. In front of the epiglottis and on the base of the tongue is an accumulation of lymphoid tissue called the lingual tonsil. The variation in size and shape of the lingual tonsil is very marked. Generally it is scarcely more than a rather close aggregation of separate nodes, giving simply a roughened appearance to the base of the tongue. Sometimes, however, it develops in two lateral masses which may be so large as to be more or less pendulous.

Below the lingual tonsil there are two depressions, the bottom of which represents the junction of the epiglottic mucous membrane with that of the tongue. These depressions are called valleculæ. The valleculæ are separated by a distinct fold of mucous membrane, the median glossoepiglottic fold, or as it is sometimes called the frenum of the epiglottis. Each is bounded externally by another fold of mucous membrane, the lateral glossoepiglottic fold.

The pyriform sinuses are deep depressions somewhat boat-shaped, elongated in a vertical direction, placed on each side of the upper part of the larynx between the ala of the thyroid cartilage and the thyrohyoid membrane on the outside, and the arytenoepiglottic fold on the inside. They are bounded anteriorly by the lateral glossoepiglottic folds, and posteriorly pass gradually down into the laryngopharynx.

The blood supply of the laryngopharynx is derived solely from the external carotid, and chiefly through the ascending pharyngeal branch. Other contributory branches are the ascending palatine branch of the facial, and the tonsillar branch of the facial, also the posterior palatine and pterygopalatine branches of the internal maxillary, and sometimes a few twigs from the lingual. The smaller veins from the pharynx pass into a pharyngeal plexus which may be found between the buccopharyngeal aponeurosis and the constrictors. This plexus anastomoses with the pterygoid plexus above, and empties below either into the internal jugular or into the facial vein.

Lymphatics of the Pharynx.

The lymphatics of the pharynx consist of a network beneath the pharyngeal epithelium and the superficial layer of the mucous cutis. This network is probably most marked on the posterior surface of the larynx and in the pyriform sinuses; it is also very rich in the pharyngeal tonsil but very scanty near the esophageal opening. A less important network is found in the muscular tissue.

The superior collecting trunks generally pass first to the retropharyngeal lymph glands. They may, however, pass by these glands

and terminate in the deep cervical lymphatics, and according to Poirer, into the anterior group, but according to the researches of the author, both anatomic and clinical, they terminate in the posterior group.

The middle collecting trunks drain the mucous membrane of the tonsillar region. These vessels perforate the muscular coat just above the great cornu of the hyoid bone, and terminate in the anterior glands of the internal jugular group near the posterior belly of the digastric muscle.

The inferior collecting trunks drain the lower part of the pharynx running under the mucous membrane, and tend to converge in the pyriform sinuses. They here unite with the superior lymphatics of the larynx and with them end in the glands of the internal jugular group just below the digastric muscle.

The lymph vessels of the soft palate are very numerous, forming a fine network which is more or less continuous with that of the neighboring structures. This network is richest in the uvula. There are separate collecting trunks from the superior and inferior surfaces and from the faucial pillars. The collecting trunks from the superior surface are more or less united with the collectors from the nasal fossæ which may be divided into ascending trunks and descending trunks. The former pass around the pharynx and terminate in the retropharyngeal lymph glands; the others pass down through the posterior pillars and terminate in the internal jugular glands near the digastric muscle. The collecting trunks from the inferior surface run downward through the anterior pillars and joining the collectors from the vault of the palate terminate in the internal jugular glands near the digastric muscle. The collectors of the anterior pillar unite with those from the inferior surface, and the collectors from the posterior pillar with the descending trunks of the superior surface. Occasionally some of the lymphatic vessels from the posterior pillars terminate in the glands of the internal jugular group as high up as the bifurcation of the carotids.

Nerves of the Pharynx.

The nerves of the pharynx, both motor and sensory, come mainly from the pharyngeal plexus. This plexus which lies just beneath the mucous membrane is formed by branches from the glossopharyngeal, from the pneumogastric and from the superior cervical ganglion of the sympathetic. The pharyngeal branch of the pneumogastric is really derived from the accessory portion of the spinal accessory. The faucial tonsil receives a branch directly from the glossopharyngeal, while the surrounding region and the soft palate are supplied by the

posterior and external palatine branches of Meckel's ganglion. The vault of the pharynx and the structures around the orifice of the Eustachian tube are supplied by the pharyngeal branch of Meckel's ganglion. The mucous membrane on the external posterior wall of the larynx is supplied by the superior laryngeal nerve.

The Structure of the Pharyngeal Wall.

Surrounding the mucous membrane of the pharynx is a distinct layer of connective tissue, the pharyngeal aponeurosis. This fascia varies in thickness being usually strongest where the muscular wall of the pharynx is weakest; and it gradually thins out as the lower end of the pharynx is approached. Above it blends with the periosteum at the base of the skull, and is attached to the Eustachian tubes, the margins of the posterior nares and to other portions of the skull from which the pharyngeal constrictors arise. At the sinuses of Morgagni, that crescentic space between the base of the skull and the upper border of the superior constrictor, the fascia is very strongly developed. Externally, the pharyngeal aponeurosis is intimately associated with the constrictors, and forms the capsule of the faucial tonsil.

The muscular wall of the pharynx is made up of two strata, the internal or circular layer consisting of the three constrictors, and an external, or more properly longitudinal layer, consisting of fibres from the stylopharyngeus and from the palatopharyngeus muscles. The three constrictor muscles appear as modified cones, the middle overlapping the superior, and the inferior overlapping the middle.

The **Superior Constrictor Muscle** arises from the lower half of the posterior border of the internal pterygoid plate, below this from the pterygomandibular ligament and from the internal surface of the mandible just back of the last molar tooth. It is also attached anteriorly to the mucous membrane of the floor of the mouth. The upper fibers of the muscle curve upward and are inserted into the pharyngeal spine of the occipital bone. This arching of the upper fibers forms a crescentic interval in the pharyngeal wall called the sinus of Morgagni. Through this opening pass the Eustachian tube and the levator and tensor palati muscles. The middle and inferior fibres of the superior constrictor pass posteriorly, radiating upward and downward to be inserted into the median raphé on the posterior wall of the pharynx. The lower fibres are overlapped by the middle constrictor.

The **Middle Constrictor Muscle**, somewhat smaller than the superior, arises from the stylohyoid ligaments and from both the small and great cornua of the hyoid bone. Its fibres, radiating upward and downward, pass posteriorly to be inserted into the median raphé of

the pharynx. The lower fibres are overlapped by the upper fibres of the inferior. The internal laryngeal artery and nerve pass through the interval between the superior and middle constrictors.

The **Inferior Constrictor Muscle** arises from the oblique line of the thyroid cartilage and from the sides of the cricoid. Its fibres radiating mostly upward, pass posteriorly to be inserted into the median pharyngeal raphé. The lower fibres blend with the musculature of the upper end of the esophagus. At the lower edge of the muscle the external laryngeal artery and nerve come into relation with the larynx.

The longitudinal muscular fibres of the pharynx are made up of two distinct muscles, the palatopharyngeus and the stylopharyngeus.

The **Palatopharyngeus Muscle** forms the posterior faucial pillar. It is composed of two layers, a thin posterior superior sheet spreading through the substance of the soft palate, and a thicker anteroinferior layer which arises from the posterior border of the hard palate. These two layers partially envelop the azygos uvulæ and levator palati muscles. They unite at the lower edge of the soft palate where they receive additional fibres from the Eustachian tube and passing downward, spread out in a thin sheet in the wall of the pharynx. The posterior fibres, under cover of the middle and inferior constrictors, are inserted into the aponeurosis of the pharynx and some fibres decussate with those of its fellow of the opposite side. The anterior fibres are inserted into the posterior border of the thyroid cartilage and anteriorly merge into the stylopharyngeus.

The **Stylopharyngeus Muscle** arises from the base of the styloid process. Passing downward and forward between the two carotid arteries it penetrates the pharyngeal wall between the superior and middle constrictors. It is inserted by a broad base into the superior and posterior border of the thyroid cartilage, its fibres being here continuous with the palatopharyngeus. It is also inserted into the pharyngeal aponeurosis.

The soft palate and uvula may be considered as the anterior wall of the pharynx. They are made up of a muscular fold covered by mucous membrane.

The muscles which constitute the soft palate consist of five pairs —the palatopharyngeus (already described), the palatoglossus, the azygos uvulæ, the levator palati and the tensor palati.

The **Palatoglossus Muscle** is placed directly beneath the mucous membrane of the tongue, the anterior palatal pillar, and the anterior surface of the palate. It is a thin sheet of muscular fibres which arise from the under surface of the soft palate, some of its fibres blending with those of its fellow of the opposite, and passes downward to form

the anterior pillar of the fauces. It is inserted into the sides of the tongue, and blends with the styloglossus and deep transverse fibres of the tongue.

The **Azygos Uvulæ Muscle** is found between the layers of the palatopharyngeus and arises from the posterior nasal spine and the aponeurosis of the soft palate. The two narrow bundles unite as they proceed downward to the tip of the uvula.

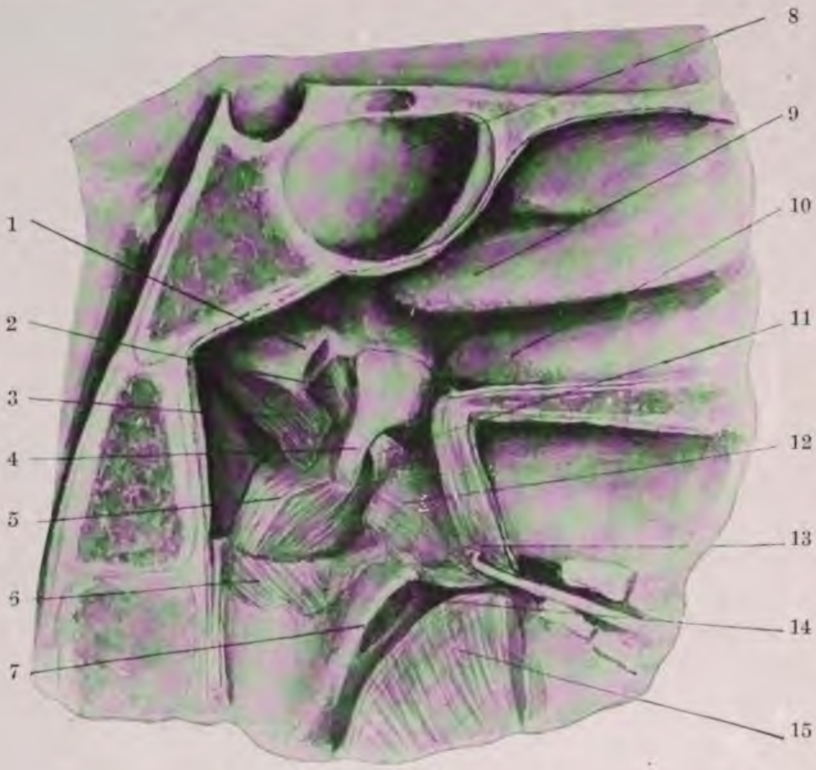


Fig. 63.

Dissection showing the relation of the tensor palati and the levator palati muscles. The levator is cut permitting the soft palate to be drawn forward.

1, Eustachian cartilage; 2, Tensor palati muscle; 3, Levator palati muscle; 4, Hamular process; 5, Internal pterygoid muscle; 6, Middle constrictor of pharynx; 7, Posterior palatal pillar; 8, Sphenoid sinus; 9, Middle turbinate; 10, Inferior turbinate; 11, Tendon of tensor palati muscle; 12, Insertion of levator palati muscle; 13, Cut edge of velum palati; 14, Palatal tonsil; 15, Section of tongue.

The **Levator Palati Muscle** arises from the inferior surface of the apex of the petrous bone close to the carotid canal. Its fibres forming a rounded belly, run parallel to and in close approximation with the under surface of the Eustachian tube, to which, however, it is not attached. It is inserted in a radiating manner into the soft palate below

the ostium of the tube. The action of this muscle on the Eustachian tube is not exactly understood. The contraction of the muscle by increasing its circumference tends to raise the floor of the tube which, by decreasing the perpendicular width of the lumen of the tube, increases the horizontal, and this probably increases the patulency of the tube.

The **Tensor Palati Muscle** is the real abductor or dilator tubæ. It arises in part from the scaphoid fossa of the internal pterygoid plate and the alar spine of the sphenoid bone, and in part from the outer surface, or the hook-like border of the cartilaginous wall, and the membranous part of the Eustachian cartilage. Running downward so as to form an acute angle with the cartilaginous portion of the tube, the muscle descends between the internal pterygoid muscle and the internal pterygoid plate. It terminates by a rounded tendon which passes around the hook of the hamular process and is inserted beneath the levator palati into the posterior border of the hard palate, as well as the aponeurosis of the soft palate. The action of this muscle, by pulling on the cartilaginous hook of the Eustachian tube, tends to slightly unfold it, which action increases the lumen of the tube.

The nerve supply to the musculature of the pharynx is chiefly through the spinal accessory by way of the pharyngeal plexus. This plexus supplies the constrictors of the pharynx, the palatoglossus, the palatopharyngeus, the azygos uvulæ, and the levator palati. The tensor palati is supplied from the otic ganglion, the stylopharyngeus by the glossopharyngeal nerve, and the inferior constrictors receive branches from the vagus through the external and recurrent laryngeal nerves.

THE LARYNX.

The larynx should be looked upon as the upper part of the trachea, especially modified for the production of the voice sound. Its construction is such as to permit the instant approximation and adjustment of two elastic bands, the vocal cords. These may be thrown into the required vibrations by a column of air forced up through the trachea. To accomplish this purpose numerous joints, ligaments and muscles are necessary. By reason of the beauty and perfection of the arrangement of these various structures the larynx is one of the most interesting organs of the body to the anatomist. It is situated in the median line of the neck just in front of the esophagus, and is very loosely attached to the surrounding structures. On each side posteriorly are the large vessels of the neck, and above are the hyoid bone and tongue.

The interior of the larynx opens into the lower portion of the pharynx just back of and below the base of the tongue. The aditus laryngis is obliquely placed facing upward and backward. It is bordered above by the epiglottis, on each side by the arytenoepiglottic folds, and posteriorly by the mucous membrane covering, the cartilages of Wrisberg (cuneiform cartilages) and of Santorini (cornicula laryngis). These cartilages surmount the arytenoid cartilages and follow their movements.

The interior of the larynx is divided into three parts by the false and true vocal cords (ventricular and vocal bands).

Superior Division.

The superior division of the laryngeal cavity is compressed laterally where the ventricular bands or false cords separate it from the middle division. The anterior wall is formed in greater part by the posterior surface of the epiglottis. The upper part of the posterior surface of the epiglottis is concave except the tip which is turned slightly forward. Below, the epiglottis shows a distinct swelling, the cushion of the epiglottis. This swelling corresponds in position to the thyroepiglottic ligament. The lateral walls are smooth except for two slight vertical elevations, the anterior being due to the cuneiform cartilage and the posterior to the anterior margin of the arytenoid cartilage and the cartilage of Santorini. The shallow grove between these elevations is called the philtrum ventriculi of Merkel. The anterior of these elevations runs to the posterior end of the false vocal cords while the posterior passes downward to the true cords. The narrow posterior wall is formed by the interarytenoid fold and varies in breadth according to the degree of approximation of the arytenoid cartilages.

The **Ventricular Bands**, or false cords, form a partial floor of the superior division of the larynx. In front they arise from the angle between the two wings of the thyroid cartilage, and they reach backward only to the swelling on the lateral wall caused by the cuneiform cartilages. They are never in apposition and they never obscure the margin of the true vocal cords from view. The chief support of this fold of mucous membrane is the thin superior thyroarytenoid ligament and a few muscle fibres. The distance in the adult male larynx from the ventricular band to the summit of the arytenoid cartilages is about one-half inch and to the tip of the epiglottis one and a half inches.

Middle Division.

The middle division of the larynx is limited above by the false cords and below by the true. On each side and covered by the ven-

tricular bands is the laryngeal sinus or ventricle of Morgagni. Its cavity is somewhat larger than its opening and it reaches from the anterior angle of the alæ of the thyroid cartilage back to the anterior border of the arytenoid cartilage. This ventricle of Morgagni is extremely variable both in shape and size. It may consist simply of a single broad pocket extending upward between the ventricular band and the ala of the thyroid cartilage or it may be a branched structure with a varying number of terminal crypts. Occasionally there exists a short branch directed downward from the main pocket. The walls of the sinus contain quite a large deposit of lymphoid tissue and frequently if not always definite germinating follicles are present so that the whole structure is very similar to a large tonsillar crypt. The upward extension of the sinus is quite commonly spoken of as the laryngeal saccule and it does not usually extend upward beyond the border of the thyroid cartilage, though in rare instances it may reach to the posterior part of the hyoid bone.

The **True Vocal Cords** are shorter but more prominent than the false and extend from the angle formed by the alæ of the thyroid to the vocal processes of the arytenoid cartilages. In cross section the cord is prismatic with the free edge pointing upward, as well as toward the median line. In front, the cords meet and form the anterior commissure. Posteriorly, they end at the vocal processes of the arytenoid cartilages, but their surface lines are continued over the median side of the arytenoid cartilages, joining posteriorly to form the posterior commissure. The true cords with the opening between them constitute the true glottis, or rima glottidis which is generally designated the glottis.

Inferior Division.

The inferior division of the larynx is somewhat flattened laterally above and below where its walls slope outward and downward from the vocal cords. Its walls are in greater part made up by the inner surface of the cricothyroid ligament.

Cartilages of the Larynx.

The **Cricoid Cartilage** is the lowest and is placed directly on top of the trachea. It is shaped somewhat like a signet ring, with the signet part or posterior lamina projecting from the upper side and the upper edge sloping rather gradually downward and forward to form the anterior circle. The ring is circular below corresponding to the shape of the trachea, but above it is somewhat laterally compressed. On top of the posterior lamina are two oval convex facets which look somewhat out-

ward as well as upward. They are the articulating surfaces for the arytenoid cartilages and are separated by a faint median notch. On the posterior surface are two depressed areas for the attachment of the posterior cricoarytenoid muscles. On the posterior part of the lateral surface of the cricoid, a vertical ridge runs downward from the arytenoid articulation. On this ridge, just above the lower border of the cartilage, is a circular facet for articulation with the inferior horn of the thyroid cartilage. The inner surface of the cricoid is smooth.

The **Arytenoid Cartilages,** two in number, are perched on the anterior part of the summit of the posterior lamina of the cricoid. They are irregularly pyramidal in shape and have three surfaces and a base. When the cartilages are in position for phonation one surface faces directly toward the median line, another posteriorly and the third outward and forward. The posterior and anteroexternal surfaces are somewhat concave, slightly triangular, narrowed vertically and fairly even. A small sesamoid cartilage is frequently found invested by the perichondrium on the external border of the arytenoid cartilage. The apex is directed upward, but is curved slightly inward and backward. There are two important processes, one the external inferior angle called the processus muscularis, and the other the anterior inferior angle called the processus vocalis.

The **Thyroid Cartilage** makes up the greater part of the framework of the larynx. It consists essentially of two large alæ joined together in front, but separated posteriorly by the interposition of the posterior lamina of the cricoid and of the two arytenoid cartilages. The anterior junction involves only the lower two-thirds of the whole height of the alæ, leaving a well-marked notch in the median line. At the bottom of this notch, the thyroid cartilage forms the most anterior portion of the larynx, and the prominence due to its projection is called the pomum Adami. There is great variation in the angle of the junction of the two cartilages. In infants it is more of a curve than an angle, while the average for the adult male is about 90° and for the adult female almost 120°. The superior border of the ala is convex upward, while the lower border is almost straight. The posterior free edge of each ala is prolonged upward almost to the hyoid bone, forming the superior cornu and downward to the articulation facet on the side of the cricoid forming the inferior cornu. On the external surface of each ala somewhat posterior to its middle is a ridge running diagonally from above, behind, downward and forward. It is usually spoken of as the oblique line and begins above at a prominence just below the superior border of the ala called the superior

tubercle. It ends on the inferior border in another prominence called the inferior tubercle.

The **Epiglottic Cartilage** is a thin lamina of yellow elastic cartilage shaped somewhat like a broad and warped paddle, with its handle below terminating in the strong thyroepiglottic ligament. Its surface is irregularly indented by depressions and there are numerous perforations running through the cartilage. Its upper end is free, rising just behind the base of the tongue.

The **Lesser Cartilages** of the larynx are six in number. The two cartilagines triticeæ are small nodules situated just above the superior cornu of the thyroid cartilage in the lateral thyrohyoid ligament. The cartilages of Santorini or the corniculate cartilages, two in number, are perched on the apices of the arytenoid cartilages and are enclosed in the posterior part of the arytenoepiglottic fold of mucous membrane. In this same fold, immediately external to the cartilages of Santorini, are the cartilages of Wrisberg or the cuneiform cartilages. They are inconstant structures but generally present.

Articulations and Ligaments of the Larynx.

The laryngeal joints with their ligaments form one of the most interesting anatomic features of the larynx.

Joints.—The cricothyroid joints are diarthrodial with a pivotal and also a gliding movement. The circular facets on the internal surface of the inferior cornu of the thyroid cartilage are bound fast by a capsular ligament to the corresponding slightly elevated circular facets on the sides of the cricoid cartilage. The posterior part of the capsular ligament is strengthened by a ligamentous thickening. The cricoarytenoid joints are more complicated but are also diarthrodial. They, too, possess a pivotal movement as well as a lateral gliding motion, and, according to some authorities, a slight anteroposterior rocking motion. The articular facet of the cricoid is convex while that of the arytenoid is concave. Both articular surfaces are elliptical and they never accurately coincide with one another. There is a distinct capsular ligament which is strengthened posteriorly by a prominent band, which limits the anterior rocking motion or displacement of the arytenoid cartilage. The lateral gliding motion of this joint, permits the two arytenoid cartilages to approach one another or separate, thus closing or opening the posterior third of the glottic chink. The pivotal movement allows the vocal process to move toward or away from the median line causing adduction or abduction of the vocal cords.

There are two important membranes in the larynx, the cricothy-

roid and the thyrohyoid. These lie in the intervals between the cartilages as their names designate.

The **Cricothyroid Membrane** is an important structure and consists of three portions; two lateral divisions and a central. These divisions are all attached below to the upper border of the arch of the cricoid cartilage. Their upper attachments, however, are very different. The central portion which is somewhat triangular in shape, is strong, tense, and elastic. The base is attached to the upper border of the anterior part of the cricoid arch and the narrowed top to the lower border of the thyroid cartilage. The lateral portions form the side walls of the subglottic part of the larynx and are lined internally only with mucous membrane. They arise below from the upper border of the cricoid cartilage and passing internally to the alæ of the thyroid find their upper termination in the whole of the length of the inferior thyroarytenoid ligaments, the supporting band of the true cords. In front, the thyrohyoid membrane is also attached to the inner surface of the thyroid alæ near the notch, and behind to the vocal processes of the arytenoid cartilages. The lateral cricoarytenoid and thyroarytenoid muscles lie directly on the outer surface of the lateral part of the cricothyroid membrane.

The **Thyrohyoid Membrane** is attached along the upper border of the thyroid cartilage and to the internal surface of the hyoid bone. Its central or anterior portion is thick and elastic and forms the median thyrohyoid ligament. This ligament is attached below to the thyroid notch and above to the upper margin of the posterior surface of the hyoid bone. Where the ligament passes behind the bone a bursa is generally found separating the two. Posteriorly the hyoid membrane terminates in a strong cord-like ligament: the lateral thyrohyoid ligament. This ligament runs from the tip of the great cornu of the hyoid bone to the extremity of the superior cornu of the thyroid cartilage. It contains the small cartilago triticea. The inner surface of the thyrohyoid membrane is covered by the mucous membrane of the pharynx, while the epiglottis is separated from the median thyrohyoid ligament by a cushion of fat.

There are two thyroarytenoid ligaments, the inferior and superior.

The **Inferior Thyroarytenoid Ligament** is really the thickened upper border of the lateral parts of the cricothyroid membrane. It is the supporting ligament of the true vocal cords and is attached anteriorly to the middle of the thyroid angle close to its fellow, while posteriorly it blends with the vocal process of the arytenoid cartilage.

This ligament contains numerous yellow elastic fibres and sometimes near its anterior end a small nodule of elastic cartilage.

The **Superior Thyroarytenoid Ligament** is a much less important structure and while thinner and weaker is longer than the inferior. It supports the ventricular bands. It is attached anteriorly to the thyroid angle just above the inferior and posteriorly to a small tubercle on the anterior surface of the arytenoid just above the processus vocalis. There are a few elastic fibres in it but it is mostly composed of fibrous tissue, which is more or less continuous with the supporting fibres of the arytenoepiglottic fold.

Ligaments of the Epiglottis.—The epiglottis is fastened to the body of the hyoid bone by an irregular broad elastic band, the hyoepiglottic ligament. From the inferior narrowed end of the epiglottis a

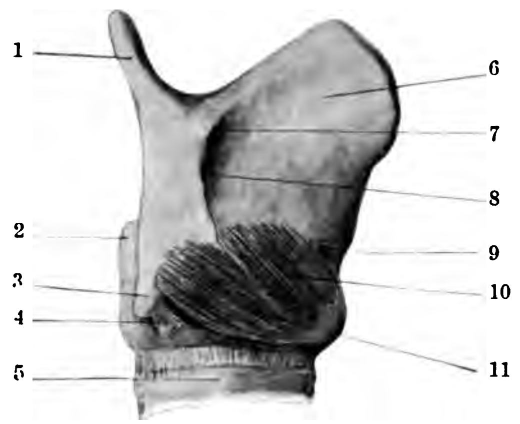


Fig. 64.

The lateral external surface of the larynx.

1, Superior cornu of thyroid; 2, Posterior lamina of cricoid; 3, Inferior cornu of thyroid; 4, Strengthening band of capsular ligament; 5, First ring of the trachea; 6, Ala of thyroid; 7, Superior tubercle of thyroid; 8, Oblique line of thyroid; 9, Central part of cricothyroid membrane; 10, Oblique portion of cricothyroid muscle; 11, Horizontal portion of the cricothyroid muscle.

strong thick ligament, composed of elastic tissue, the thyroepiglottic ligament, runs to the posterior surface of the thyroid angle just below the notch. Besides these two true ligaments the epiglottis is fastened to the tongue by three folds of mucous membrane, the median and two lateral glossoepiglottic folds. These have already been described.

The Muscles of the Larynx.

Under this head will be described only those muscles which have both their origin and insertion in some part of the larynx itself. While

some of them are contained entirely within the cavity bounded by the ala of the thyroid, the cricothyroid, the arytenoid and the posterior cricoarytenoid are on the external surface of the larynx proper.

The **Cricothyroid Muscle** arises from the anterior surface of the cricoid arch and the lower adjoining border and radiating upward and backward usually separates more or less distinctly into two divisions. The anterior of these divisions crosses the cricothyroid interval more perpendicularly than the posterior and is inserted into the lower edge and the neighboring inner surface of the ala of the thyroid. The pos-

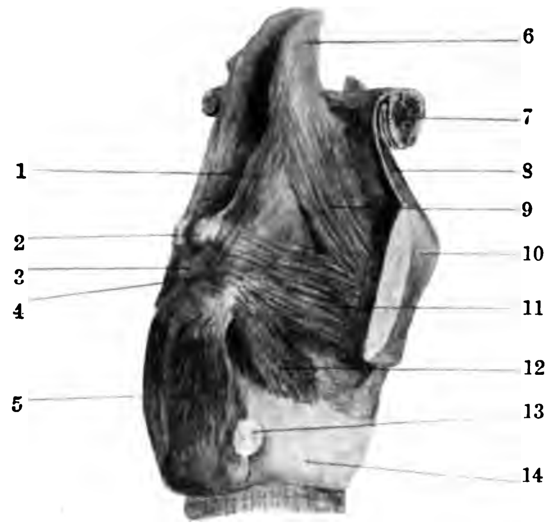


Fig. 65.

The muscles of the laryngeal wall on the posterior aspect.

1, Arytenoepiglottic muscle; 2, Cartilage of Santorini; 3, Arytenoideus obliquus muscle; 4, Arytenoideus transversus muscle; 5, Cricoarytenoideus posticus muscle; 6, Epiglottis; 7, Retrohyoid bursa; 8, Thyrohyoid muscle; 9, Thyroepiglottic muscle; 10, Thyroid cartilage; 11, Thyroarytenoideus muscle; 12, Cricoarytenoideus lateralis muscle; 13, Articular facet for inferior cornua of thyroid; 14, Cricoid cartilage.

terior division is inserted into the anterior aspect of the inferior cornu of the thyroid. The cricothyroid is sometimes rather closely associated with the inferior constrictor of the pharynx.

The **Posterior Cricoarytenoid Muscle** arises by a broad base from a depression which covers almost the entire half of the posterior surface of the cricoid lamina. Its fibres, converging as they ascend in a slightly lateral direction, are inserted into the posterior surface of the muscular process of the arytenoid.

The **Arytenoid Muscle** consists of two parts, a superficial oblique layer and a deep transverse layer.

The oblique arytenoid is a paired muscle, one muscle crossing the other in the median line on the posterior aspect of the larynx. Each muscle consists of a narrow bundle which arises from the posterior side of the muscular process of the arytenoid and, running obliquely upward, passes around the outer side of the summit of the opposite arytenoid cartilage. Some of the fibres are here inserted into the arytenoid but many continue upward into the arytenoepiglottic fold, as the arytenoepiglottic muscle, and are joined near the epiglottis by fibres from the thyroepiglottic muscle.

The transverse arytenoid is a transverse sheet of muscle beneath the oblique, stretching between the posterior aspect of the outer border of each arytenoid cartilage. Some of the fibres are apparently continuous with the fibres of the thyroarytenoid.

The **Lateral Cricoarytenoid** is somewhat smaller than the posterior. It springs by a rather broad base from about the middle third of the upper border of the lateral part of the cricoid arch and also from the neighboring part of the cricothyroid membrane. Its fibres running backward and upward converge to be inserted into the front of the muscular process of the arytenoid cartilage.

The **Thyroarytenoid Muscle** consists of two parts, an external and an internal, which, however, are closely blended. A large part of the lower border of this muscle is closely associated with the upper border of the lateral cricoarytenoid.

The **External Thyroarytenoid Muscle** is a broad sheet just within the ala of the thyroid cartilage and spreads from the upper surface of the lateral cricoarytenoid to above the level of the vocal cord. It arises in front from the lower half of the thyroid ala close to the angle and also from a portion of the lateral cricothyroid membrane. Its fibres running backward parallel with the vocal cord are inserted for the greater part into the muscular process of the arytenoid cartilage. A few fibres pass around this cartilage and are continuous with the transverse fibres of the arytenoid.

The **Thyroepiglottic Muscle** is really an off-shoot from the upper border of the external thyroarytenoid which turns upward to be inserted into the upper part of the arytenoepiglottic fold and the free margin of the epiglottis.

The **Internal Thyroarytenoid Muscle** is triangular in cross section and closely associated with the vocal cord. It arises from the thyroid angle in front and is inserted first by several muscular slips into the vocal cord itself and second into the outer side of the vocal process and adjoining outer surface of the arytenoid cartilage.

The portion of the muscle which is inserted into the cord is sometimes spoken of as the aryvocalis muscle.

The **Action of the Muscles** of the larynx is concerned both with the movement of the vocal cords and the closure of the upper laryngeal aperture.

The cricothyroid acts as a tensor of the vocal cords by tilting the thyroid cartilage downward and forward (oblique fibres) and by pulling the cartilage as a whole slightly forward (transverse fibres). As the arytenoids are prevented from riding forward on the top of the cricoid lamina, this forward tilting of the thyroid cartilage must put tension on the vocal cords. In opposition to this action of the cricothyroid, the thyroarytenoid relaxes the vocal cords by approximating the angle of the thyroid cartilage with the arytenoid cartilage. While

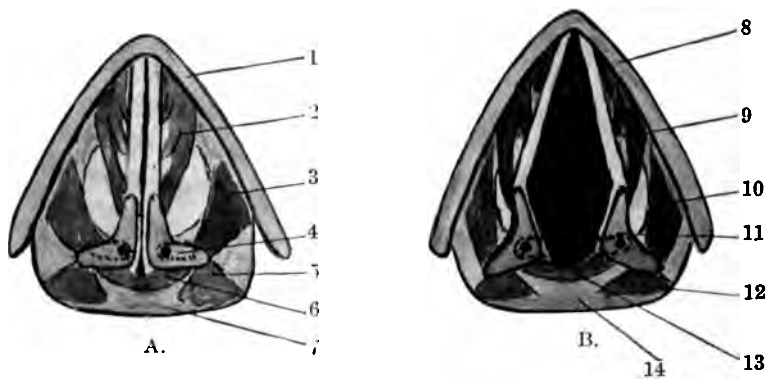


Fig. 66.

Diagrams illustrating closed and open glottis.

1, Thyroid cartilage; 2, Thyroarytenoideus internus; 3, Cricoarytenoideus lateralis; 4, Arytenoid cartilage; 5, Cricoarytenoideus posticus; 6, Arytenoideus transversus; 7, Cricoid cartilage; 8, Thyroid cartilage; 9, Thyroarytenoideus internus; 10, Cricoarytenoideus lateralis; 11, Arytenoid cartilage; 12, Cricoarytenoideus posticus; 13, Arytenoideus transversus; 14; Cricoid cartilage.

the thyroarytenoid, as a whole, relaxes the whole vocal cord, it is probable that the falsetto voice results from a partial contraction of the internal thyroarytenoid by relaxing only a portion of the cord while the cricothyroid makes the remaining part of the cord tense, the tense portion only being capable of vibration. The posterior cricoarytenoid muscle by rotating the arytenoid cartilage so that the vocal process turns outward, is the abductor of the cords while the lateral cricoarytenoid muscle by rotating it in the opposite direction becomes the adductor of the cords.

The transverse arytenoid muscles bring the central sides of the arytenoid cartilages together and thus complete the closure of the

glottic chink after the vocal cords proper have been approximated by the inward rotation of the arytenoid cartilage.

The closure of the superior laryngeal aperture during swallowing is accomplished chiefly by the oblique portion of the arytenoid acting in concert with the arytenoepiglottic muscles. The transverse arytenoid with the thyroarytenoid muscles probably aid in the closure by approximating the arytenoid cartilages and compressing the sides of the larynx at about the position of the false vocal cords. The superior aperture when closed presents a "T" shaped fissure with the top of the "T" approximately parallel with the transverse axis of the epiglottis and the stem running between the two arytenoid bodies. The muscles therefore which affect this closure must be looked upon in effect as true sphincters.

The Nerve Supply of the Larynx.

The nerves supplying the larynx are two in number, and both are branches of the pneumogastric or vagus.

The **Superior Laryngeal Nerve** leaves the vagus high up in the neck, and passes obliquely downward and forward on the inner side of the internal and external carotid arteries. On approaching the larynx, it divides into two unequal parts, a larger internal, and a smaller external branch.

The **Internal Laryngeal Nerve** passes between the middle and inferior pharyngeal constrictors and reaches the interior of the larynx by penetrating the thyrohyoid membrane. Sensation is supplied by this nerve to the mucous membrane of the larynx from the epiglottis down to the upper part of the trachea. This nerve probably also contains vasomotor and secretory fibres, which it supplies to the whole of the laryngeal mucous membrane.

The **External Laryngeal Nerve** runs downward on the external surface of the inferior constrictor, ending at the cricothyroid muscle which it supplies. Branches are sent to the inferior constrictor muscle and probably, a few motor twigs pass to the arytenoid.

The **Recurrent or Inferior Laryngeal Nerve** leaves the pneumogastric in the lower part of the neck, and turns upward to supply all of the intrinsic muscles of the larynx except the cricothyroid, and part of the arytenoid.

THE LYMPHATIC SYSTEM OF THE NECK.

The cervical lymphatic nodes are divided into two main groups, the superficial or collecting nodes and the deep or terminal nodes. The

superficial group is arranged as a sort of a collar around the upper part of the neck with a few irregular extensions. This pericervical circle is composed of the following subgroups:

1. Suboccipital group and aberrant glands of the nape of the neck.
2. Mastoid group.
3. Parotid and subparotid group.
4. Submaxillary group with the facial glands as an off-shoot.
5. Submental group.
6. Retropharyngeal group.

The **Suboccipital Group** of glands are rather inconstant structures varying from one to three in number and usually are placed on the occipital insertion of the complexus muscle just external to the external border of the trapezius. They receive the lymph vessels from the back of the head and their efferent vessels terminate in the highest nodes of the substernomastoid group.

The **Mastoid Group** or retroauricular glands, generally two in number, lie on the mastoid insertion of the sternomastoid. These glands receive their afferent vessels from the temporal portion of the hairy scalp, from the internal surface of the auricle except the lobule and from the posterior surface of the external auditory meatus. They empty into the highest glands of the deep lateral chain.

The **Parotid Group** consists of glands in the parotid space either external to the glands, the superficial nodes, or in the actual substance of the parotid, the deep nodes. The deeper parotid nodes are scattered throughout the substance of the parotid but for the most part are grouped around the external carotid artery. They are quite numerous though some are very small and can be seen only by the microscope. These glands receive afferent vessels from the external surface of the auricle, from the external auditory meatus, from the tympanum, from the skin of the temporal and frontal regions and possibly also from the eyelids and base of the nose. It is possible that at times they drain the nasal fossæ also and the posterior part of the alveolar border of the superior maxilla. The afferents run into the upper substernomastoid glands near the exit of the external jugular vein from the parotid.

The **Subparotid Glands** belong in reality to the parotid group but are placed beneath the parotid, between it and the pharyngeal wall in the lateropharyngeal space. Suppurative inflammation of these glands gives rise to lateral pharyngeal abscesses. Their afferents come from the nasal fossæ, from the nasopharynx and from the Eustachian, while their efferents pass to the upper glands of the deep cervical chain.

The **Submaxillary Group** consists of from three to six nodes situated along the length of, and immediately beneath, the lower border of the mandible. The largest of the group is generally found near the facial artery. These glands are just beneath the fascia and are more or less intimately associated with the upper border of the submaxillary salivary gland. Their afferent vessels come from the external nose, the cheek, from the upper and the external part of the lower lip, from practically the whole of the gums and from the anterior third of the sides of the tongue. The efferent vessels running over the surface of the submaxillary salivary glands empty generally into the glands of the deep cervical chain near the bifurcation of the common carotid. They may at times pass to glands further down the chain.

The **Facial Glands** are small inconstant structures found in the course of the afferent vessels leading to the submaxillary nodes. They generally form three groups. The inferior or supramaxillary rest on the jaw just in front of the masseter muscle. Occasionally there is a gland immediately on the edge of the jaw at this position called the inframaxillary gland. A less frequent group of glands is the middle or buccinator group on the external surface of the buccinator muscle. All of these buccinator glands lie outside of the buccal fascia. There may, however, be a subfascial gland or a submucous gland. The third group is still less constant and is situated just to one side of the nose.

The **Submental Group** consisting of from one to four glands are found in the triangle bounded by the anterior bellies of the two digastric muscles and the hyoid bone. The afferent vessels of this group are from the skin of the chin from the centre portion of the lower lip and from the mucous membrane covering the external portion of the alveolus, from the floor of the mouth and from the tip of the tongue. The efferent vessels run either to the submaxillary gland or directly downward to a node of the deep cervical chain situated on the internal jugular vein just above where it is crossed by the omohyoid.

The **Retropharyngeal Group** consisting generally of two glands is placed back of the posterior pharyngeal wall near its outer edge being almost 2 cm. from the median line. These glands are separated from the atlas by the rectus capitis anticus major muscle and are in rather close relation externally with the sheath of the great vessels of the neck. Suppurative inflammation of the nodes leads to retropharyngeal abscess. In this case the abscess starts laterally but being limited externally by the fascia covering the vessels enlarges medianward. Occasionally there are small inconstant nodes back of the pharyngeal wall almost in the median line. The retropharyngeal glands receive

their afferents from the mucous membrane of the nasal fossæ and accessory sinuses, from the nasopharynx including the pharyngeal tonsil, from the region of the Eustachian tube and possibly from a part of the tympanic cavity. It must be said, however, that the retropharyngeal lymphatic glands are only interrupting nodes placed on the collecting lymphatics as they pass from the upper part of the back of the throat to the posterior group of the deep cervical chain. The afferent lymph vessels of the retropharyngeal lymph glands follow the same general course as those efferents which come directly from the posterior pharyngeal wall and pass behind the great vessels of the neck to reach the posterior edge of the sternomastoid muscle, and empty into the upper nodes of the posterior group of the deep cervical chain.

Fig. 67.

Dissection showing the upper deep cervical lymph nodes.

1, Masseter muscle; 2, Facial artery; 3, Submaxillary gland; 4, Hypoglossal nerve; 5, Digastric (posterior belly) and stylohyoid muscles; 6, Anterior group of the deep cervical lymph nodes; 7, Facial nerve; 8, External jugular lymph node; 9, Sternomastoid muscle; 10, Posterior group of the deep cervical lymph nodes; 11, Spinal accessory nerve; 12, Sternomastoid artery; 13, Internal jugular vein.

The **Descending Cervical** chain of lymph nodes consists of two sets of glands, the deep cervical chain and several more or less important secondary and more superficial chains. The deep glands situated on each side of the neck comprise from fifteen to thirty nodes on an average, although these figures do not represent the extremes of variation. This group of glands is variously termed the carotid chain, the sub-

sternomastoid group, or the deep lateral glands of the neck, and may theoretically and clinically be divided into two groups, although anatomically they are closely associated. They extend from just beneath the ear downward under the sternocleidomastoid muscle, generally only as far as the point where the omohyoid crosses the vessels and nerves, but occasionally reaching as far as the junction of the internal jugular and subclavian vein. The more superficial division of the deep lateral chain lies posteriorly and is called the external group. The external glands are generally small, and placed in part beneath the posterior border of the sternocleidomastoid, and occasionally extend so far down the anterior border of the trapezius muscle as to come into rather close relation with the supraclavicular glands. They rest rather irregularly distributed, on the external surface of the splenius, levator anguli scapulæ, cervical plexus and the spinal accessory nerve.

The anterior or deep division of the main group is placed directly over the great vessels of the neck, and is termed the internal jugular group. These nodes are situated beneath the anterior border of the sternocleidomastoid muscle, and when enlarged may be forced anteriorly until some of them appear immediately below the angle of the jaw. One or two large glands are constantly found below the posterior belly of the digastric, just above the spot where the thyrolingual-facial vein opens into the internal jugular. These nodes receive lymphatics from the tongue while immediately above the digastric is a large node which drains the tonsil and surrounding region. A few glands are sometimes found between the internal jugular and the prevertebral muscles.

The **Accessory** or **Superficial Descending Cervical** chain consists of four groups, the external jugular chain, the superficial anterior cervical chain, the deep anterior cervical chain, and the recurrent chain.

The External Jugular Chain consists usually of two or three nodes resting on the external surface of the sternomastoid just below the parotid gland. Occasionally one or two nodes are found further down along the course of the veins. Their afferent vessels come from the auricle and parotid region and their efferent vessels terminate in the upper nodes of the deep cervical chain. It is claimed that sometimes an efferent vessel from these glands may follow along the course of the external jugular vein and empty into the supraclavicular glands.

The Superficial Anterior Cervical Chain consists of two or three inconstant nodes on the anterior jugular vein.

The Deep Anterior Cervical Chain may be divided into three distinct groups: the prelaryngeal, the prethyroid and pretracheal.

The prelaryngeal group consists of one, two or three inconstant glands most frequently found in the triangular space bounded by the

two cricothyroid muscles. When present their afferents come from the middle lymphatic pedicle of the larynx. Their efferents may run either to the pretracheal nodes or to the lower nodes of the deep lateral chain.

The prethyroid glands are usually absent.

The pretracheal group is usually present and consists of one or more very small nodes. Their afferents come from the thyroid body and the prelaryngeal nodes and their efferents terminate in the lower nodes of the deep lateral chain.

The Recurrent Chain consists of from three to six minute nodes along the course of the recurrent laryngeal nerves. Their afferent vessels come from the inferior pedicle of the larynx, from the neighboring region of the trachea and esophagus and a part of the thyroid body. It is important to remember that the efferent vessels of this chain terminate in the inferior nodes of the deep lateral chain instead of proceeding downward to the mediastinal glands. It is, however, possible that occasionally an efferent from these nodes passes directly to the superclavicular glands.

The **Supraclavicular Group** of lymph glands occupies the supraclavicular or subclavian triangle. These glands are generally very numerous and are imbedded in the adipose tissue found in this triangle the so-called "fettpolster" of Merkle. In the upper part of the triangle they are just beneath the superficial cervical fascia and rest on the splenius, levator anguli scapulæ and scalenus muscles. Also they hold important surgical relations with some of the lower branches of the cervical plexus which supply the trapezius and with the ascending cervical artery. The more inferior glands of this group are in greater part placed in front of the middle layer of cervical fascia lying very close to the terminal subfascial portion of the external jugular and descending branches of the cervical plexus. Some nodes more deeply placed are found behind the omohyoid and the middle layer of cervical of the subclavian.

The majority of authors place this chain of glands as an auxiliary fascia being just in front of the brachial plexus and the third portion group of the deep cervical chain, but my own researches have led me to believe that the supraclavicular nodes rarely show any anastomosis with any of the cervical lymph nodes. This is a most important anatomic feature because a direct connection between these nodes and the cervical lymph glands would establish the necessary link in the lymphatic chain from the tonsils to the apex of the lung.

The afferents of the supraclavicular glands come, first from the posterior part of the scalp and from the muscles of the neck, second

from the skin of the pectoral region, third from the skin of the arm over the cephalic vein, fourth from the humeral chain of the axillary group of glands, and fifth (doubted by some authors) from the parietal pleura covering the apex of each lung. The efferent vessel of the supraclavicular glands generally empties into the jugular trunk.

The jugular lymphatic trunk, the terminal vessel of the deep lateral chain, usually terminates on the right side in the angle of junction of the internal jugular and subclavian veins. On the left side it most frequently terminates in the thoracic duct.

TOPOGRAPHIC ANATOMY OF THE ANTERIOR CERVICAL TRIANGLE.

Viewed from the side, the neck is divided by the sternocleidomastoid muscle into two triangles, an anterior, and a posterior triangle. The anterior cervical triangle is subdivided into a digastric (submaxillary), a carotid (superior carotid) and a muscular (inferior carotid) triangle by the digastric and omohyoid muscles, while the posterior triangle is divided by the posterior belly of the omohyoid into the occipital and supraclavicular triangles.

The skin of the neck is loosely attached and the creases and folds formed by the flexion of the head as a rule run from above and behind obliquely forward and downward. It is important to remember the direction of these folds as incisions heal with less deformity when made either in the fold itself or parallel with its course. In the lower part of the neck the folds run more transverse, and the incision should then be less oblique following the direction of the skin fissures.

Beneath the skin is the superficial fascia. This fascia is continuous with that of the head and chest, and contains the superficial nerves and blood vessels, none of which, however, have any great surgical importance.

Between the superficial fascia and the deep fascia is placed the platysma myoides muscle. This muscle is a thin sheet covering the anterior part of the side of the neck, arising from the deep fascia of the pectoral region and from the clavicle. Its fibres extend upward and slightly forward. The greater part of the muscle is inserted into the lower border of the jaw but some of the fibres are continuous with the depressor labii inferioris, the depressor anguli oris, and the risorius. The anterior fibres meet across the middle line just below the chin.

Just beneath the posterior part of the platysma is the external jugular vein. The line of this vein is from the angle of the jaw to the

middle of the clavicle. It is formed by the junction of the posterior auricular vein with the posterior branch of the temporomaxillary vein. It passes downward external to the deep fascia, crossing obliquely over the sternomastoid muscle, and pierces the deep fascia in the anterior part of the subclavian triangle. It crosses in front of the third part of the subclavian artery and empties into the subclavian vein.

Almost immediately posterior to the vein running parallel with its upper part will be found the great auricular nerve. This nerve is the

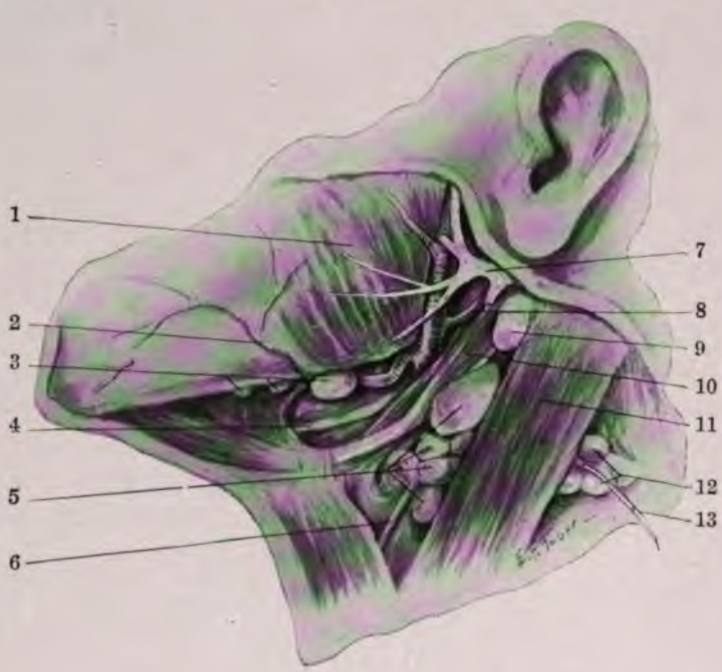


Fig. 68.

Superficial dissection of the carotid triangle.

1, Masseter muscle; 2, Facial artery; 3, Submaxillary gland; 4, Hypoglossal nerve; 5, Anterior group of the deep cervical lymph nodes; 6, Superior thyroid artery; 7, Facial nerve; 8, Posterior auricular artery; 9, External jugular lymph node; 10, Posterior belly of the digastric muscle; 11, Sternomastoid muscle; 12, Posterior group of the deep cervical lymph nodes; 13, Spinal accessory nerve.

largest of the superficial, or cutaneous branches of the cervical plexus. It pierces the deep cervical fascia just above the middle of the posterior border of the sternomastoid muscle and ascends in close relation with the external jugular vein. Immediately beneath the ear it divides into three branches; the anterior or facial branch which supplies the skin over the parotid gland and anastomoses in the substance of this gland with the facial nerve; the auricular branch, which supplies both

sides of the lower part of the pinna; and the mastoid branch, which supplies the skin of the scalp behind the ear. Above the auricularis magnus, the small occipital nerve, a branch of the cervical plexus passes upward along the posterior border of the sternomastoid. Just below the great auricular nerve the superficial cervical nerve pierces the deep fascia and passes forward and transversely over the sternomastoid and beneath the external jugular vein.

The deep fascia of the neck invests all the muscles and forms aponeurotic coverings for the esophagus, pharynx and trachea, capsules for the salivary glands, and sheaths for the larger blood vessels. This fascia is attached behind to the ligamentum nuchæ and the spinal process of the seventh cervical vertebra. A superficial layer passes forward, enveloping the trapezius muscle and uniting in front of the muscle, it crosses over the posterior triangle of the neck to envelop the sternomastoid muscle. Above it is attached to the mastoid process and the superior curved line of the occipital bone and below to the clavicle. From the anterior edge of the sternomastoid muscle it continues forward to the median line of the neck in a single layer. In the front part of the neck the upper attachment is to the lower border of the jaw, the styloid process, and the hyoid bone.

Below, near the sternum, it divides into two layers, an anterior and a posterior which are attached respectively to the anterior and posterior edges of the upper portion of the sternum. The interval thus formed (the space of Gruber) contains fat, the sternal head of the sternomastoid and the anterior jugular veins.

Just below the mastoid process a superficial layer of the deep fascia is continued over the parotid gland and the masseter muscle as the parotid and masseteric fascia, and is attached to the lower border of the zygoma.

From the deep fascia processes extend between the various structures of the neck. At the angle of the jaw it becomes thickened and forms the stylomandibular ligament, which extends from the tip of the styloid process to the posterior border of the angle of the mandible. Other thickenings of this fascia form the pterygospinous ligament and the stylohyoid ligament. This latter ligament runs from the tip of the styloid process to the lesser cornu of the hyoid bone.

Two main processes are given off from the deep fascia, a posterior and an anterior. The posterior process, or prevertebral fascia, arises at the anterior border of the trapezius muscle, and covers the numerous muscles of the back of the neck, the brachial plexus, the phrenic and cervical sympathetic nerves and passes inward behind the large vessels, the pharynx and the esophagus to meet its fellow of the other

side. It is attached above to the base of the skull and below to the first rib as far forward as the anterior border of the anterior scalenus muscle. It also passes down into the chest over the longus colli muscle and the bodies of the vertebræ. It forms the sheath of the subclavian and axillary vessels by a process beginning just outside of the anterior scalenus muscle. In conjunction with the anterior process it forms the sheath of the carotid artery and internal jugular vein.

The anterior process, or pretracheal fascia, passes inward and forward from the anterior border of the sternomastoid just in front of the trachea, and envelops the thyroid gland. It is attached below to the first rib.

The deep cervical fascia surrounding the trachea and the great vessels follows these structures down into the chest where it is continuous with the fibrous layer of the pericardium. The prevertebral and the pretracheal fasciæ divide the neck into three compartments. The anterior compartment contains the anterior belly of the omohyoid, the sternothyroid and the sternohyoid muscles. The middle contains the pharynx, esophagus, trachea and the thyroid gland; while the posterior contains the vertebral column, the upper vertebral muscles, the scalene muscles, the levator anguli scapulæ, and the whole musculature of the back of the neck with the exception of the trapezius.

The most important compartment formed by the deep cervical fascia is the visceral compartment. This compartment is bounded anteriorly by the pretracheal fascia, posteriorly by the prevertebral fascia and laterally by the fascia forming the sheath of the deep blood vessels. It extends from the base of the skull downward into the posterior mediastinum. In front it runs from the hyoid bone into the anterior part of the superior mediastinum.

The **Sternocleidomastoid Muscle** is the most prominent muscular landmark of the neck. It forms a distinct ridge of swelling, running from the mastoid process downward and forward across the side of the neck to the region of the sternoclavicular articulation. It has two heads, one, the sternal head, a narrow tendinous structure which arises from the anterior surface of the manubrium of the sternum, and a clavicular head, broader and only partly tendinous, which arises from the upper surface of the inner third of the clavicle. It is inserted by a rather broad attachment into the outer surface of the mastoid process, and into the adjoining portion of the superior curved line of the occipital bone. Its anatomic relations are very important. Its anterior border, beginning above, is the superficial landmark for the location of the facial and spinal accessory nerves and of all the structures which occupy the carotid triangle, such as the jugular and adjoining lymph

nodes of the upper deep cervical chain, the internal jugular vein, the carotid arteries and the various branches of the external carotid, and, if they are desired to be approached near their origin, the hypoglossal, the pneumogastric, the sympathetic, and the glossopharyngeal nerves. Lower down, its anterior border is the landmark for the common carotid and internal jugular veins, the descendens hypoglossi, and the superior and recurrent laryngeal nerves. The anterior part of the upper extremity of the muscle is covered by the parotid gland. About one-fourth of the way down its anterior border, the sternocleidomastoid muscle covers the posterior belly of the digastric muscle as it passes upward and backward to its insertion into the mastoid process.

The **Submaxillary Salivary Gland** is situated just beneath the horizontal ramus of the mandible near the angle and is partially covered by it. It occupies a triangular space which is bounded externally and above by the inner surface of the mandible, externally and below by the skin and fascia as they pass from the edge of the jaw to the neck, and internally by the mylohyoid muscle. The posterior part of the gland also rests internally on the hyoglossus, the posterior belly of the digastric and the stylohyoid muscles. It is crossed externally by the facial vein, while the facial artery passes through a groove on its external inferior surface. The posterior end of the gland which is really the most bulky portion very often reaches to the anterior edge of the sternomastoid muscle. Along its upper border just beneath the lower edge of the jaw, the submaxillary lymph nodes are sometimes very closely associated with its capsule, so that in malignant disease with metastasis to the submaxillary lymph nodes it is probably best to remove the salivary gland, as well as the lymph nodes in order to be sure that the disease is eradicated. The submaxillary or Wharton's duct leaves the gland from the anterior end and is often accompanied by a tongue-like prolongation of the glandular tissue.

The **Digastric Muscle** consists of two bellies, a posterior and an anterior. The posterior belly arises from the digastric groove on the internal surface of the mastoid process. It runs forward and downward, passing through the stylohyoid muscle, where it becomes tendinous. This tendon is attached to the upper surface of the hyoid bone by a pulley-like band from the cervical fascia. The tendon passes on through this pulley and becoming fleshy, forms the anterior belly, which is inserted into the lower border of the lower jaw close to the symphysis.

The **Stylohyoid Muscle** arises from the base of the styloid process of the temporal bone, and after enclosing the digastric, is inserted into the body of the hyoid bone. Its course is almost parallel with that of the digastric. These two muscles form the posterior inferior boundary

of the submaxillary triangle, and are important landmarks for the deeper structures. Superficial to them will be found the anterior division of the temporomaxillary vein, the facial vein, and their common trunk as it passes downward and inward to join the internal jugular.

Facial Nerve.—In this position, it is well to bear in mind the relation of the supramandibular and inframandibular branches of the facial

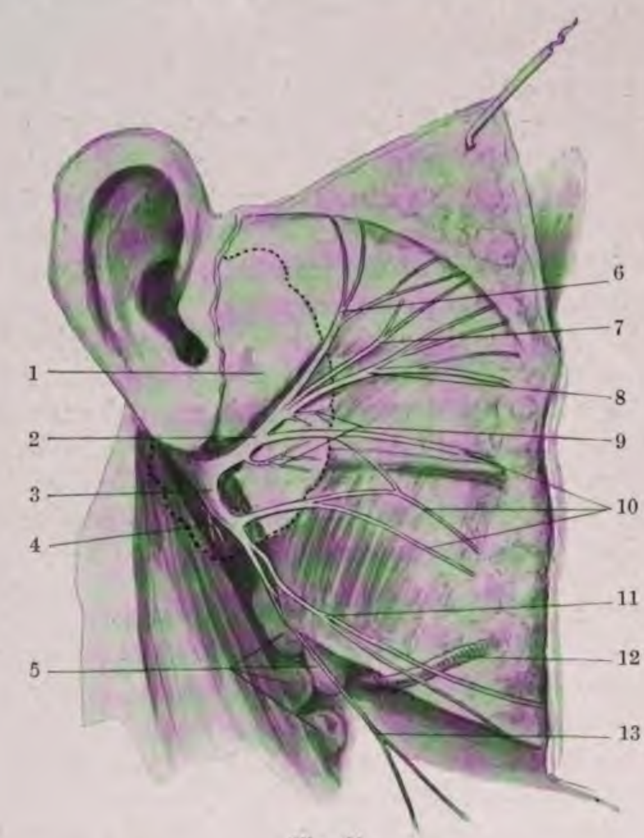


Fig. 69.

Dissection of the pes anserinus of the facial nerve. The dotted line represents the normal outline of the parotid gland.

1, Parotid gland; 2, Temporofacial division; 3, Cervicofacial division; 4, Stylohyoid and digastric branches; 5, Lymph nodes of the upper deep cervical group; 6, Temporal branch; 7, Malar branch; 8, Infraorbital branch; 9, Branches to parotid gland; 10, Buccal branch; 11, Supramandibular branch; 12, Facial artery; 13, Inframandibular branch.

nerve. These nerves generally come from a common stem, the cervicofacial. The inframandibular branch passes down from beneath the inferior edge of the parotid gland to supply the platysma myoides, and to form a communication with the superficial cervical nerve of the cervical plexus. From its superficial position, this nerve is almost bound to

be cut in the operations on this region. Fortunately, the results are of little consequence. The supramandibular branch, emerging from beneath the parotid gland, slightly in front of the inframandibular branch, sweeps forward and downward to the inferior edge of the mandible, follows this to the anterior border of the masseter muscle, and turning slightly upward supplies the depressor anguli oris, the depressor labii inferioris, and the orbicularis oris. The position of

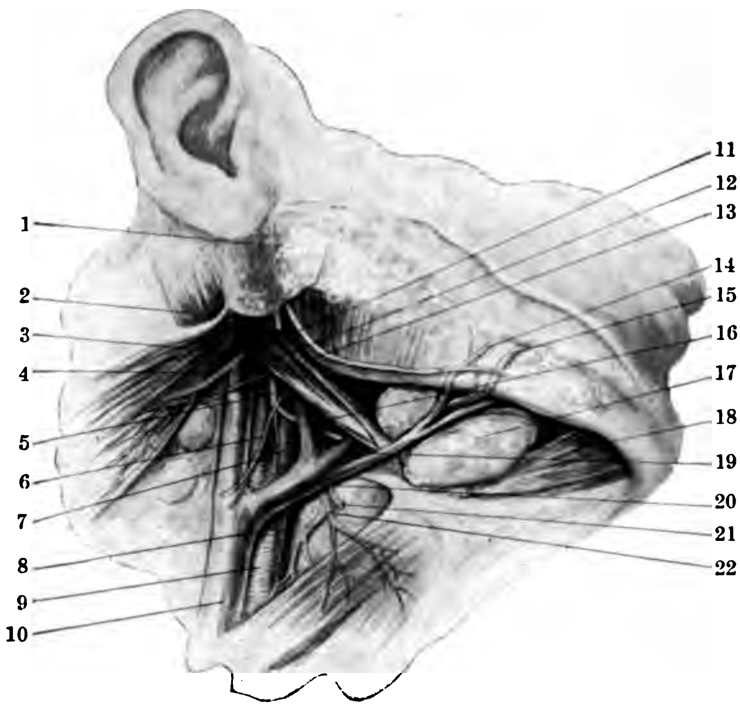


Fig. 70.

Deep dissection of the carotid triangle.

1, Parotid gland; 2, Inframandibular branch of facial nerve; 3, Sterno-mastoid muscle reflected; 4, Spinal accessory nerve; 5, Hypoglossal nerve; 6, Internal carotid artery; 7, External carotid artery; 8, Descendens hypoglossi; 9, Common carotid artery; 10, Internal jugular vein; 11, Supramandibular branch of facial nerve; 12, Posterior belly of digastric muscle; 13, Stylohyoid muscle; 14, Facial vein; 15, Facial artery; 16, Anterior division of temporomaxillary vein; 17, Submaxillary salivary gland; 18, Anterior belly of digastric muscle; 19, Lingual vein; 20, Temporofacial vein; 21, Internal laryngeal nerve; 22, Superior thyroid artery.

this branch of the nerve is somewhat variable, and occasionally, just after it emerges from the parotid gland, its course is so far down as to make it very open to injury in removing the lymph nodes at the angle of the jaw. Cutting of this nerve is deplorable as it paralyzes one-half of the lower lip.

Internal Jugular Vein.—At about this depth it is important to remember the position and relation of the large veins in the neck. The internal jugular vein which is a continuation of the lateral sinus, begins above by a dilation called the bulb which occupies the posterior compartment of the jugular foramen. It runs obliquely downward and forward, terminating behind the clavicle near the sternum where it unites with the subclavian vein to form the innominate. At first it is behind the internal carotid artery, but gradually passes around as it descends until finally it is on the outer side of the carotid artery. In the lower part of the neck it sometimes overlaps it in front. The right vein is not very closely associated with the artery at the base of the neck, whilst the left vein is almost in front of the carotid artery on that side. An important tributary to this vein is the common facial vein. This latter vein is formed by the union of the facial vein and the anterior division of the temporomaxillary vein. The common facial vein crosses over the external carotid artery generally a little below the posterior belly of the digastric muscle and frequently has to be ligated and cut to expose the external carotid near its base. Sometimes the common facial vein gives off at the anterior edge of the sternomastoid a branch which may be quite large and which runs along the anterior border of the sternomastoid to the suprasternal fossa where it joins the anterior jugular vein. The internal jugular vein occupies the connective tissue sheath in common with the carotid arteries and the pneumogastric nerve.

The **Hypoglossal Nerve** leaves the skull through the anterior condyloid foramen. It arches downward and forward passing to the outer side of both the internal and external carotid arteries and internal to the posterior belly of the digastric and the stylohyoid muscles. As it crosses the internal carotid artery it passes below and around the occipital artery. In its course this nerve communicates with the pharyngeal branch of the vagus, and sends a small branch to the thyrohyoid muscle. It passes forward beneath the stylohyoid muscle and external to the hyoglossus muscle just above the hyoid bone. In this position it is an important landmark for an approach to the lingual artery. The lingual branches of this nerve are distributed to the hyoglossus, the geniohyoid and the geniohyoglossus muscles and practically to all the intrinsic muscles of the tongue. The descendens hypoglossi, a rather large branch of the hypoglossal, descends along the external surface of the carotid sheath, though sometimes it occupies the interior of the sheath and forms with a branch from the second and third cervical nerves the ansa hypoglossi. Branches from this plexus run to the omohyoid, the sternothyroid and the sternohyoid, but it is probable that the

innervation of these muscles comes through the cervical nerves and not through the hypoglossal.

The **Common Carotid Artery** arises on the right side of the neck from the innominate artery, and on the left side from the arch of the aorta. In the neck, however, the two arteries have practically the same relations. It is important to remember, however, that the thoracic duct passes immediately behind the left carotid artery just before arching downward to enter the innominate vein, and the recurrent laryngeal nerve has already passed to the inner side of the artery before the artery enters the neck proper. On the right side the recurrent laryngeal nerve lies behind the carotid artery in the lower part of the neck. At about the level of the first ring of the trachea the inferior thyroid artery, a branch of the thyroid axis, passes immediately behind the common carotid. The sternomastoid branch of the superior thyroid artery crosses over the common carotid along the anterior edge of the omohyoid at about the level of the sixth cervical vertebra. A line for the common carotid is from the upper part of the sternoclavicular articulation to a point midway between the angle of the jaw and the tip of the mastoid process. The point of bifurcation into the two terminal branches, the external and internal carotid arteries, is usually on a level with the upper border of the thyroid cartilage. It is, however, not uncommon for the external carotid to be given off considerably higher up, and this anomalous condition sometimes makes it difficult to quickly reach the external carotid for ligation.

The **Omohyoid Muscle** which crosses the common carotid externally consists of two bellies, the anterior and the posterior. It arises from the upper border of the scapula and the suprascapular ligament and, passing forward and slightly upward, becomes tendinous beneath the sternomastoid muscle. This part of the muscle is called the posterior belly. The anterior belly begins from this intermediary tendon and passes obliquely upward and forward to be inserted into the outer edge of the lower border of the body of the hyoid bone. The intermediary tendon is held in place to the first rib by a process of the deep cervical fascia. The anterior belly of the muscle forms the upper boundary of the inferior carotid triangle and crosses the common carotid artery at about the level of the cricoid cartilage.

The **External Carotid Artery** is usually about two and a half inches long and supplies blood to the upper part of the neck and nearly the whole of the head and face, outside of the cranium. Its course is generally at first slightly forward, then backward, upward and inward, behind the posterior belly of the digastric and the stylohyoid muscles to the under surface of the parotid gland. It terminates near the upper

part of the gland, generally beneath it but sometimes in its substance by dividing into the internal maxillary and the superficial temporal arteries.

The **Superior Thyroid Artery,** the first branch of the external carotid, arises from the front of the carotid just below the tip of the great cornu of the hyoid bone. The artery runs at first forward, but soon turns downward, sending branches to the larynx, sternomastoid muscle and the thyroid gland. In the beginning of its course it lies on the inferior constrictor muscle, and is in very close relation with the external laryngeal branch of the superior laryngeal nerve. For a short distance after leaving the cover of the sternomastoid the artery is directly under the deep cervical fascia, but lower down it is covered by the omohyoid, sternohyoid and sternothyroid muscles and is generally overlapped by its accompaying vein.

The **Ascending Pharyngeal Artery,** the second branch, arises from the inner surface of the external carotid, almost opposite the superior thyroid and runs upwards on the constrictor muscles of the pharynx to supply the wall of the pharynx and the soft palate. A palatine branch from this artery is not a constant structure, but when present takes the place of the ascending palatine branch of the facial, and supplies the upper part of the tonsil.

The **Lingual Artery,** the third branch, springs from the front of the external carotid just above the superior thyroid and about opposite the tip of the great cornu of the hyoid bone. The artery forms a loop upwards in the first part of its course, and here, except that it is crossed superficially by the hypoglossal nerve, it is covered only by the skin, fascia and platysma. Reaching the posterior border of the hyoglossus muscle it passes beneath this structure just above the great cornu of the hyoid bone. It terminates as the ranine artery, and is the chief blood supply to the tongue.

The **Facial Artery,** the fourth branch, arises from the carotid immediately above the lingual, but passes upward to the inner side of the posterior belly of the digastric and runs forward and downward through a special groove in the submaxillary gland to the margin of the jaw, just in front of the masseter muscle. Sometimes, however, after reaching the upper border of the digastric muscle, it loops upwards until it comes into close proximity with the inferior pole of the tonsil, though always separated by the middle constrictor muscle. After reaching the edge of the jaw, the facial artery passes just beneath the fascia and skin to supply the various structures of the face, terminating in the angular artery on the side of the nose.

The **Occipital Artery,** the fifth branch, arises from the back of the

external carotid just below the posterior belly of the digastric and running upward and backward under the posterior belly of the digastric, it crosses, first the internal carotid artery, then the hypoglossal nerve, the pneumogastric nerve, the internal jugular vein and lastly the spinal accessory nerve. The hypoglossal nerve hooks around the artery just as it branches from the carotid. By passing between the transverse process of the atlas and the base of the skull, the occipital artery reaches the digastric groove of the mastoid process. In this part of its course it is separated from the vertebral artery by the rectus capitis lateralis muscle.

The **Posterior Auricular Artery,** the sixth branch, leaves the back of the external carotid just above the digastric muscle and passing under the posterior part of the parotid gland runs between the mastoid process and external auditory meatus, where it is in close relation with the posterior auricular branch of the facial nerve.

The **Internal Maxillary Artery,** the seventh branch, one of the terminal branches of the external carotid, begins behind the neck of the lower jaw and passes forward to supply practically all of the internal structures of the face. The first part of the artery is closely associated with the auriculotemporal nerve and internal maxillary vein, and it lies between the sphenomandibular ligament and the neck of the jaw. Its second part, occupying the zygomatic fossa, may run either over or under the lower head of the external pterygoid muscle. When it passes between the heads of the external pterygoid muscle it comes into close relationship with the third division of the fifth nerve. The third part of the artery runs between the lower heads of the external pterygoid, thence through the pterygomaxillary fissure into the sphenomaxillary fossa. This artery gives off numerous branches, one of which, the posterior or descending palatine, runs downward through the posterior palatine canal to the roof of the mouth, where it crosses forward beneath the mucous membrane just inside the alveolar process. It gives off small branches which supply the soft palate and anastomose with the ascending palatine and tonsillar branches of the facial and probably with the ascending pharyngeal artery. Another branch, the vidian, supplies branches to the upper part of the pharynx and to the Eustachian tube. Another branch, the pterygopalatine supplies the upper and back part of the nose, the pharyngeal vault and surrounding structures.

The **Superficial Temporal Artery,** the eighth branch, the second of the terminal branches of the external carotid, begins in the upper part of the parotid gland behind the neck of the mandibular, and, dividing

into an anterior and posterior branch, supplies the anterior half of the scalp.

The **Internal Carotid Artery**, beginning at the level of the upper border of the thyroid cartilage, runs upward and inward posterior and external to the external carotid. It passes into the skull through the carotid canal of the temporal bone. Posterior to the artery and slightly internal are the rectus capitis anticus major muscle, the prevertebral fascia and the sympathetic cord. The internal jugular vein and vagus

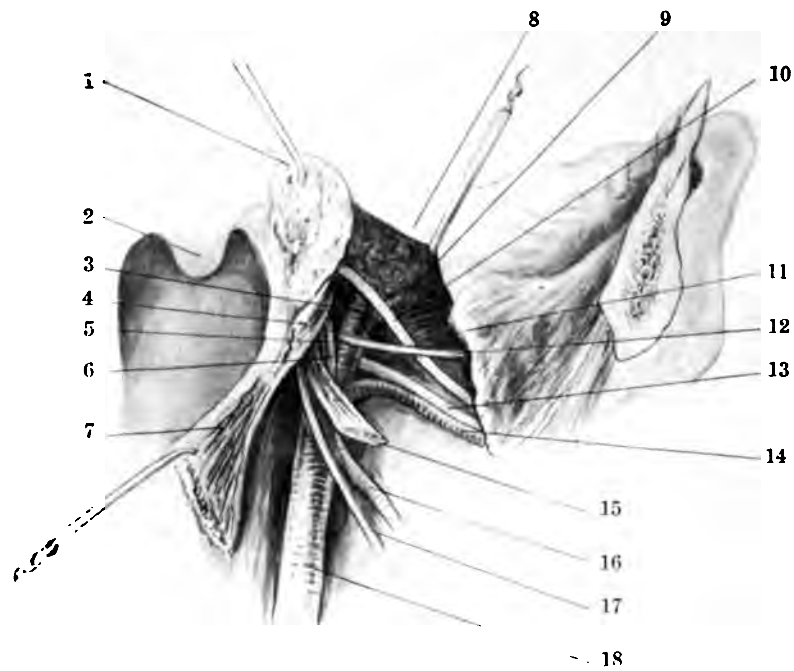


Fig. 71.

The relation of the palatal tonsil to the vessels and nerves of the carotid triangle. Portion of the mandible has been resected and the tongue removed.

1, Palatal tonsil reflected backward and upward from its bed; 2, Uvula; 3, External carotid artery; 4, Palatopharyngeal muscle; 5, Internal carotid artery; 6, Ascending pharyngeal artery; 7, Lateral pharyngeal wall drawn inward and backward; 8, Anterior palatal pillar drawn upward; 9, Facial artery; 10, Lingual nerve; 11, Cut surface of tongue; 12, Glossopharyngeal nerve; 13, Hypoglossal nerve; 14, Lingual artery; 15, Styloglossus muscle; 16, Superior thyroid artery; 17, Superior laryngeal nerve; 18, Common carotid artery.

nerve, while on a plain posterior to the artery, are generally somewhat external to it. The spinal accessory and glossopharyngeal nerves for a short distance in the upper part of the neck are found behind and slightly to the outer side passing between it and the internal jugular vein. Internally it is closely associated with the wall of the pharynx

but separated by the ascending pharyngeal artery, the pharyngeal plexus of veins and the superior laryngeal nerve. Just before the artery enters the temporal bone the levator palati muscle is found on its inner side. It is crossed externally by the hypoglossal nerve and the occipital and posterior auricular arteries, and it is separated from the external carotid by the stylopharyngeus and styloglossus muscles, the stylohyoid ligament, the glossopharyngeal nerve, the pharyngeal branch of the vagus, and some fine sympathetic twigs. The digastric and stylohyoid muscles run external both to it and to the external carotid. The upper part of the internal carotid in the neck is covered by the parotid gland. As a rule no branches are given off from the internal carotid artery, while in the neck.

The **Pneumogastric** or **Vagus Nerve** occupies the carotid sheath being placed behind and between first the internal, then the common carotid artery and the internal jugular vein. Two ganglia are found on the pneumogastric nerve as it leaves the skull through the jugular foramen. The upper and smaller one, the ganglion of the root, gives off a meningeal branch and an auricular (Arnold's nerve) branch. The latter generally communicates with the tympanic branch of the glossopharyngeal, also with the facial nerve. The lower ganglion of the trunk gives off the pharyngeal branch and the superior laryngeal nerve. The pharyngeal branch which really derives its fibres from the spinal accessory nerve, runs between the internal and external carotid arteries and helps in the formation of the pharyngeal plexus.

The **Superior Laryngeal Nerve** runs downward and inward behind the external and internal carotid arteries to the thyroid cartilage. In its course it divides into the internal and external laryngeal nerves. The internal laryngeal nerve gains access to the larynx by running between the middle and inferior constrictor muscle of the pharynx and through the thyrohyoid membrane. The external laryngeal nerve passes downward upon the inferior constrictor muscle ending in the cricothyroid in the lower part of the neck.

The **Recurrent** or **Inferior Laryngeal Nerve** is a branch of the vagus. On the right side of the neck it leaves the vagus as it passes over the subclavian artery. It then runs upward behind the subclavian, the common carotid and the inferior thyroid arteries, and behind the thyroid body. It enters the larynx by passing beneath the lower border of the inferior constrictor muscle. The left recurrent laryngeal nerve leaves the vagus as it crosses the aortic arch. Passing around and behind the arch it runs upward in the interval between the trachea and esophagus. In the neck its course is similar to that on the right side.

The **Spinal Accessory Nerve** divides in the jugular foramen, the accessory portion of the nerve joining the vagus. The spinal portion of the nerve then runs downward into the neck, occupying at first the interval between the external carotid artery and the internal jugular vein. It runs downward, outward, and then crosses obliquely backward over the vein to reach the internal surface of the sternomastoid muscle. It then pierces this muscle, sending fibres to it, and enters the posterior triangle of the neck near the exit of the cervical plexus. Crossing the posterior triangle it supplies the trapezius muscle entering on its inner surface.

The **Glossopharyngeal Nerve** leaves the skull through the jugular foramen and arching downward and forward passes between the internal carotid artery and the internal jugular vein, and below the external carotid. It passes around the outside of the stylopharyngeus muscle and the stylohyoid ligament and below the hyoglossus muscle, terminating in the tongue. It innervates the stylopharyngeus muscle and sends important branches to the pharyngeal plexus. It also sends a few direct fibres to the mucous membrane of the pharynx and another branch to form the tonsillar plexus which supplies the mucous membrane covering the tonsil and the immediate surrounding region.

The **Pharyngeal Plexus** of nerves is made up of branches from the glossopharyngeal and the pneumogastric nerves and the superior cervical ganglion of the sympathetic.

CHAPTER III.

THE SURGICAL ANATOMY OF THE EAR.

By George E. Shambaugh, M. D.

Introduction.

Nowhere is surgery more dependent on a knowledge of anatomic details than in the operations upon the ear. In the temporal bone are located a number of important anatomic structures a slight injury of which may be followed by serious results. The fact that these structures encroach on the field of operation which lies deep in the temporal bone makes the danger from injury much greater than when the operating is done in soft structures.

The perfecting of aural surgery is the direct result of the modern tendency to specialization which has made it possible for the otologist to master the complicated anatomy of this region. The first problem for the surgeon who would undertake the operations on the ear is to master the details of the anatomy of this region. This cannot be acquired from text-books nor is this knowledge readily gained by attempts to do these operations on the cadaver. A thorough grasp of the complicated anatomy of the temporal bone is best acquired by a study of preparations made especially to show this or that relation. The knowledge comes through the actual making and handling of such preparations. The most that can be hoped from a chapter on the surgical anatomy of the ear is to point out the various relations which must be kept in mind when undertaking the surgery of this region and to emphasize these relations by drawings from actual preparations. The study of such a chapter can in no sense serve as an adequate substitute for the actual handling of anatomic preparations, which after all is the only way of acquiring real anatomic knowledge. It is hoped that this chapter may serve to call the attention of the beginner to the more important surgical relations of the temporal bone so that with this as a guide he may work out for himself these relations from preparations of his own.

The Development of the Temporal Bone.

The temporal bone is formed from three parts, the pars petrosa, the pars squamosa and the pars tympanica, which in the new-born are

sharply separated by well marked sutures. Of these the petrous is the most important as it contains the labyrinth and it is from the petrous bone that the mastoid process develops. The tympanic bone in the new-born is but a shallow curved rim containing a groove, the sulcus tympanicus, for the attachment of the membrana tympani. The rim is incomplete at the upper pole, the cleft forming the incisura tympanica in which the membrane of Shrapnell is attached. The squamous bone in the new-born forms the outer covering for the recessus epitympanicus (the attic and aditus) as well as the outer covering for the antrum tympanicum. The roof of these chambers, the tegmen tympani et antri, is formed in part from the squamous bone and in part from the petrous. The suture passing directly through the tegmen is quite patulent in the new-born. This explains the ready occurrence in the young of meningeal symptoms in cases of acute suppuration of the middle ear.

The outer surface of the temporal bone in the new-born presents an appearance quite unlike that seen in the adult. The most conspicuous difference is the complete absence of an osseous external meatus. The membranous meatus is connected to the shallow rim of bone, the pars tympanica, in which the membrana tympani is attached. This close relation between the membrana tympani and the membranous external meatus accounts for the occurrence of pain in a young child whenever in cases of acute otitis media the auricle is manipulated. In older children this symptom disappears because the cartilage of the meatus is separated by a well developed bony meatus from the area of infiltration about the attachment of the membrana tympani. Another peculiarity in the new-born is the complete absence of a mastoid process. That part of the petrous bone from which the processus mastoideus develops presents a flat surface with scarcely a suggestion of a prominence from which the process develops. A conspicuous suture beginning opposite the middle of the posterior wall of the tympanum and coursing upward and backward to a notch on the posterior margin of the temporal bone marks the union between the petrous and squamous bones. (Fig. 72.) This suture, the petrosquamosal, opens directly into the antrum tympanicum and often persists in the adult as a depression into which the periosteum penetrates. The persistence of the petrosquamosal suture in children has an important practical bearing on the course of antrum infection at this age as it permits of the rapid development of a subperiosteal abscess. It explains also why a simple Wild's incision in an infant is so much more effective than in the adult. A Wild's incision in an infant for the relief of a subperiosteal abscess formed by an extension from the

antrum through the petrosquamosal suture amounts often to the same as a Schwartze operation in the adult as it gives a free opening into the antrum, the only pneumatic space developed at this age.

On the outer surface of the temporal bone, just back of the pars tympanica, at about the junction of the middle with the lower thirds of the posterior wall of the tympanic cavity, is a round opening for the exit of the facial nerve. It is important that this position of the stylomastoid opening in the infant be kept in mind when making the incision

Fig. 72.

Fig. 73.

Fig. 72. Temporal bone from new-born, showing distinctly the three parts which go to make up this bone: the pars squamosa, pars tympanica. pars petrosa. Note the absence of bony external meatus and the absence of a mastoid process. The opening of the facial canal is on the exposed outer surface of the temporal bone. (Dr. G. W. Boot's preparation.)

Fig. 73. Temporal bone from child one year old, showing the persistence of the petrosquamosal suture, also the beginning of a mastoid process which is still too small to cover the opening of the facial canal. The bony external auditory canal is beginning to form. The lower anterior part is still entirely wanting. (Dr. G. W. Boot's preparation.)

for the relief of a subperiosteal abscess, for this incision might sever the facial nerve.

In the development of the temporal bone after birth the two conspicuous changes brought about are the formation of a mastoid process and of a bony external meatus. The processus mastoideus develops largely from the petrous bone. It is first recognized as a small tubercle at about the age of one year. (Fig. 73.) Its development takes place in two directions, outward, that is external to the cavity of the tympanum, and downward below the cavity of the tympanum. It is the development of the processus mastoideus that causes the stylomas-

toid foramen to recede from the surface of the temporal bone until in the adult it lies fully 25 mm. from the outer surface of the mastoid. At the age of three years the mastoid has already assumed the shape found in the adult and the digastric groove is easily recognized. (Fig. 74.) The petrosquamosal suture has usually been obliterated with only occasionally a depression marking its site. The external bony covering of the antrum is still usually quite porous.

The development externally of the processus mastoideus is shared by both the squamous and the tympanic bones. All three enter into the formation of the bony external meatus. In its development the tympanic bone forms a trough with an opening above the posterior. This trough in the adult forms the anterior, the lower, and part of the posterior bony meatus auditorius externus. The upper wall of the bony meatus is formed by a horizontal plate from the squamous bone. The upper posterior margin of the external meatus is formed by the processus mastoideus and is developed in part from the petrous and in part from the squamous bones. It is this upper posterior part of the external bony meatus that is occupied frequently in the adult by pneumatic spaces, mastoid cells.

Meatus Auditorius Externus.

In the new-born, as already pointed out, the external auditory meatus consists only of the cartilaginous membranous portion, there being no bony meatus. In the adult this cartilaginous portion forms scarcely the outer third of the canal. In the development of the bony canal the part formed by the squamous and petrous bones pushes out beyond that formed from the tympanic bone, so that the anterior lower wall of the bony meatus is shorter than the upper and posterior wall. This deficiency is pieced out by an extension from the cartilage forming the auricle. In this cartilage which forms the outer part of the anterior lower wall of the external meatus are several clefts called the incisuræ Santorini which relieve the rigidity of this part of the canal and permit greater mobility of the auricle. Through these clefts in the cartilage a parotid abscess occasionally discharges into the external meatus and through them a furuncle in the meatus may discharge into the region of the parotid.

The anterior lower wall of the bony meatus is formed by a thin plate of bone which separates the meatus from the glenoid fosso. A severe blow on the chin may fracture this bone and drive the head of the mandible into the external meatus. The floor of the external meatus makes a decided curve downward at its inner third forming

Fig. 74.

Temporal bone from child three years old, showing the mastoid process, the bony external auditory meatus, and obliteration of the petrosquamosal suture. (Dr. G. W. Boot's preparation.)

Fig. 75.

Temporal bone from child ten years old. The adult characters of the temporal bone are developed. Persistence of depression over the mastoid showing the line of the petrosquamosal suture. (Dr. G. W. Boot's preparation.)

the sulcus of the external meatus. (Fig. 76.) The narrowest part of the external meatus is at the entrance of this sulcus. The sulcus itself

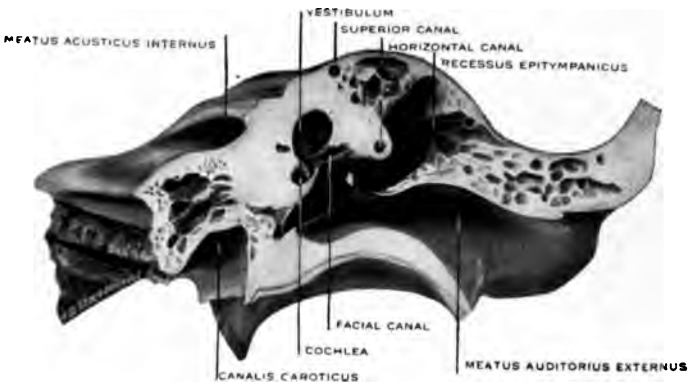


Fig. 76.

Frontal section through the adult temporal bone; the anterior part viewed from behind. Section passes through external meatus, cavum tympani, and labyrinth.

is at times so deep that insects and small foreign bodies lodging in it may be completely out of the line of direct inspection.

The upper posterior wall of the external meatus is formed from the mastoid process and this is the only part of the meatus wall en-

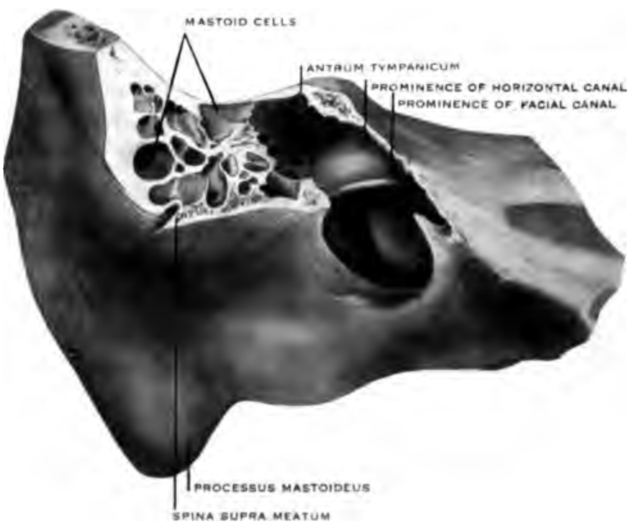


Fig. 77.

Adult temporal bone showing the position of the antrum tympanicum and mastoid cells along the upper posterior wall of the external canal.

croached on by mastoid cells. These cells may be found external to the supramental spine (Fig. 77) which is located often somewhat within

the outer margin of the meatus. The antrum tympanicum lies above the upper posterior wall of the meatus just external to the membrana tympani (Figs. 77, 78, 79). In cases of acute mastoid disease when the

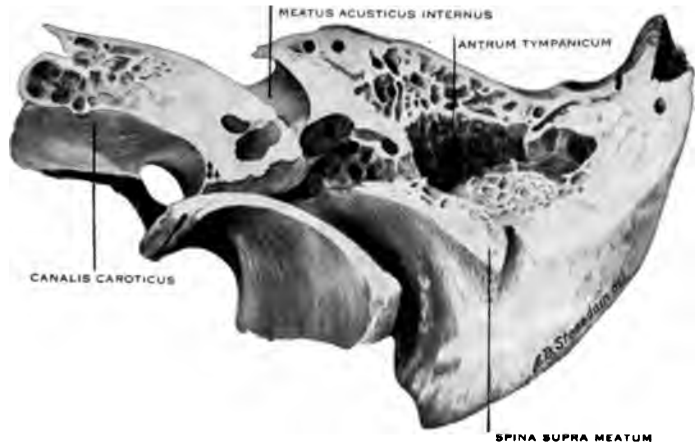


Fig. 78.

Horizontal section through the temporal bone viewed from above. Section through the external canal, cavum tympani, labyrinth and internal meatus.

temporal bone is being involved, a periostitis over this portion of the canal frequently results in a bulging or sinking of this part of the pos-

Fig. 79.

Section through mastoid process and external canal, showing pneumatic type of mastoid with the larger cells on the periphera, also the position of the antrum above and posterior to the external canal.

terior wall. A mastoid abscess frequently discharges into the external canal at this point. In case of chronic suppuration with cholesteatoma formation in the antrum the cholesteatoma frequently breaks through

into the external meatus at this point. On the other hand it should be remembered that a furuncle located along the posterior wall of the meatus may be confused with a mastoid abscess, since in addition to producing a bulging of this wall of the canal it is often associated with an infiltration and edema over the mastoid process with displacement forward of the auricle, such as a mastoid abscess produces. The relation of the facial canal to the upper and posterior walls of the external meatus is of great surgical importance especially in doing the radical mastoid operation. The inner rim of the upper wall of the external meatus lies directly over the facial canal from the point where the nerve enters the tympanum in front of the oval window until it begins to curve downward toward the stylomastoid opening. (Figs. 76 and

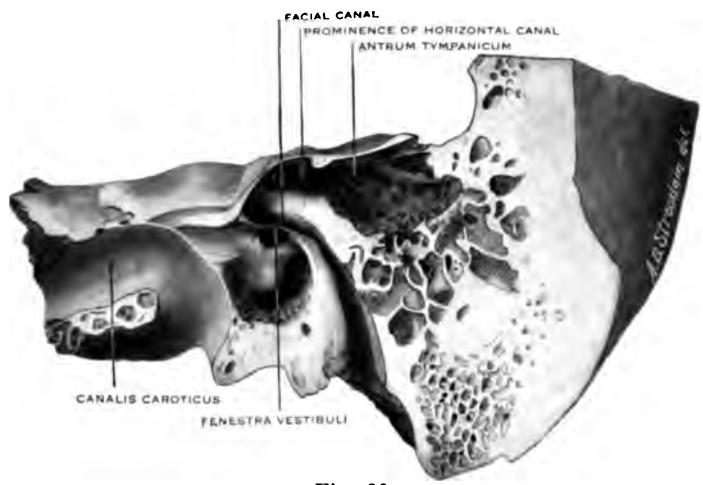


Fig. 80.
Section through temporal bone, showing the relation of the facial canal to the fenestra vestibuli and of the horizontal canal to the antrum.

80.) In this part of its course the facial nerve is covered by an extremely thin shell of bone in which dehiscence frequently occurs. From the point where the facial canal turns downward until it emerges from the stylomastoid foramen it lies in the bone which forms the posterior wall of the bony meatus. At the point where this canal enters the posterior wall of the bony meatus just posterior to the oval window it lies on a level with the inner wall of the tympanum. As it passes downward it lies out further and further along the external meatus so that at the level of the floor of the tympanum the canal lies several millimeters external to the inner wall of the tympanum. (Fig. 80.) Again the relation of the facial canal to the external meatus is such that where it enters the posterior wall of the meatus near the upper part of the tympanum it lies close to the meatus wall but as the

canal passes downward it recedes further and further from the meatus until at the level of the floor of the tympanum it lies several millimeters posterior to the external meatus. (Figs. 80 and 81.) These relations

Fig. 81.
Section through temporal bone, exposing the facial canal.

of the facial canal to the posterior wall of the external meatus make it necessary, when performing the radical mastoid operation, to leave

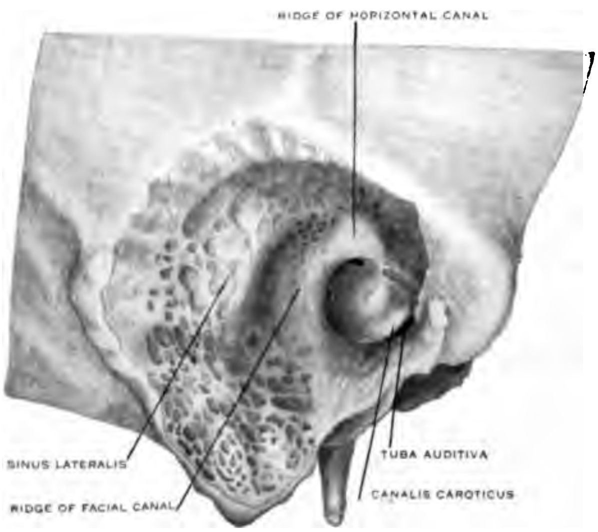


Fig. 82.
Adult temporal bone, showing anatomic relations after a complete tympanomastoid exenteration.

standing a part of the posterior wall of the canal. (Fig. 82.) On the other hand it is possible to remove the ledge of bone lying in front of the facial canal which separates the canal from the meatus.

The Processus Mastoideus.

The mastoid process is surgically the most important part of the temporal bone. Most of the serious complications arising in the course of suppurative middle ear disease develop from disease of this process and the operations undertaken for the relief of these complications begin with an exenteration of the mastoid.

The outlines of the mastoid process present a cone-shaped appearance, the apex of the cone pointing downward, the base of the cone uppermost. The size in the adult is not constant. The outer surface is more or less rounded or flattened depending largely on the size. In

Fig. 83.
Adult temporal bone, showing the typical relation of the linea temporalis extending in a horizontal direction back from the external canal.

the well developed process the outer surface is more rounded while in the small process the surface is more flattened.

The markings on the outer surface of the mastoid process are of importance. They serve as a guide in making an opening into the antrum. The base of the mastoid is marked off by a horizontal ridge, a continuation of the root of the zygoma. This is known as the linea temporalis and is constant although not developed as prominently in some cases as in others. The linea temporalis usually extends directly back from and on the same plane with the root of the zygoma. (Fig. 83.) It lies, therefore, a little above the external meatus. In some cases, however, it curves down around the upper posterior margin of

the external meatus and takes its horizontal course from about the middle of the opening of the external meatus. (Fig. 84.) In other cases the linea temporalis takes a sharp curve upward immediately back of the upper posterior margin of the external meatus. (Fig. 85.) It is important to understand these variations since this ridge often serves as a guide in opening the antrum and as a landmark indicating the line of separation between the mastoid and the middle brain fossa. In keeping below the linea temporalis when opening the mastoid process there should be no danger of entering the middle fossa. The cases in which the linea temporalis takes a sharp curve upward just back of the external meatus are exceptions. Here the middle fossa can

Fig. 84.
Adult temporal bone showing the linea temporalis making a marked curve down along the posterior border of the external meatus before turning backward. (Anatomic variation.)

be readily entered by chiseling directly inward from beneath this ridge. As a guide for finding the antrum the linea temporalis can usually be relied on. The opening is made immediately below the ridge quite close to the meatus, and the direction of the external meatus followed until the antrum is reached. There is but one type of process in which this method could fail to lead to the antrum. This is when the linea temporalis curves down along the posterior margin of the external meatus before coursing backward. (Fig. 84.) In these cases the opening made into the mastoid as indicated could readily miss the antrum and might lead to an injury of the facial nerve.

Another constant landmark on the outer surface of the temporal bone is the spina suprameatum located at the upper posterior margin of the external meatus. (Figs. 74 and 77.) This is a small roughened area for the attachment of the superior ligament of the auricle. The size of the spine varies. It is usually quite conspicuous but, especially in children, it may be so small as to escape detection. As a guide in opening the antrum it can always be relied upon as its position at the upper posterior margin of the external meatus is constant. The antrum, which lies some distance out along the upper posterior wall of the external meatus, is readily reached by making an opening in the mastoid just back of the supremeatal spine and following the direction of the external meatus. To lay off an imaginary triangle in this local-

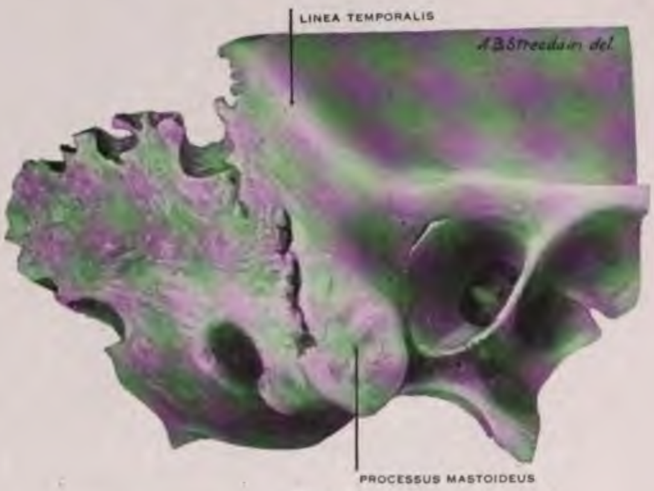


Fig. 85.

Adult temporal bone showing the linea temporalis making a curve upward at the posterior margin of the external meatus. (Anatomic variation.)

ity before making the opening into the antrum would only complicate the situation and lead to confusion in the mind of the beginner. The simplest method of finding the antrum when the suprameatal spine can be recognized is the direction given above. In all cases in which the spine cannot be made out no difficulty will be experienced in locating the antrum if it be kept in mind that this cavity lies above the upper posterior wall of the external meatus a short distance external to the drum membrane. The opening in the mastoid should be made close to the external meatus just below an imaginary line passing through the upper margin of the external meatus and the occipital protuberance. If the opening follows closely the direction of the external meatus one cannot fail to find the antrum if that cavity has not been completely

obliterated, as it may be in rare cases of chronic suppuration of the middle ear.

Other markings on the outer surface of the mastoid are the opening for the emissary mastoid vein, the tympanomastoid, and the petrosquamosal sutures. The opening of the emissary mastoid vein is along the posterior margin of the mastoid. (Fig. 84.) It frequently represents a point of increased tenderness in cases of thrombosis of the lateral sinus. The location of the opening should be kept in mind when operating on mastoid cells located along the posterior margin of the process. The tympanomastoid suture is seen along the posterior margin of the external meatus. It marks the separation between the part of the posterior wall of the meatus formed from the tympanic bone and

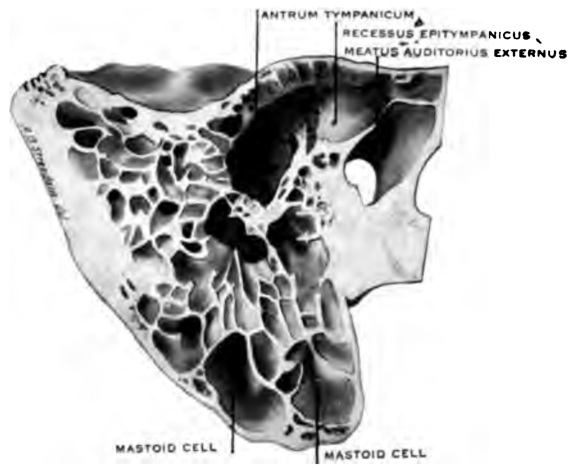


Fig. 86.

Section through mastoid process, antrum tympanicum, and external canal. (Pneumatic type.)

that formed from the mastoid process. The petrosquamosal suture is well marked in the young child but is usually quite obliterated in the adult.

The mastoid process in the adult usually contains pneumatic spaces which communicate with the antrum and are known as mastoid cells. In the new-born there is an absence of a mastoid process and of mastoid cells. The antrum, which is in reality part of the tympanum and is known as the antrum tympanicum, exists in the new-born. As the mastoid process develops pneumatic spaces develop and as a rule completely fill the process. (Figs. 79, 86, 87.) These cells often extend beyond the confines of the mastoid process forward into the root of the zygoma and posterior into the occipital bone. The cells lying near the antrum are as a rule small in size. The cells occupying the tip of

the mastoid and those lying along the posterior margin are usually much larger. (Figs. 79, 86, 87.) In Figs. 88 and 89 is shown an unusu-

Fig. 87.
Pneumatic type of mastoid. Larger cells arranged along the periphery.

ally large mastoid cell outside the mastoid process lying internal to the digastric groove. Such a mastoid cell is especially dangerous because in the first place a suppuration here could produce no symptoms

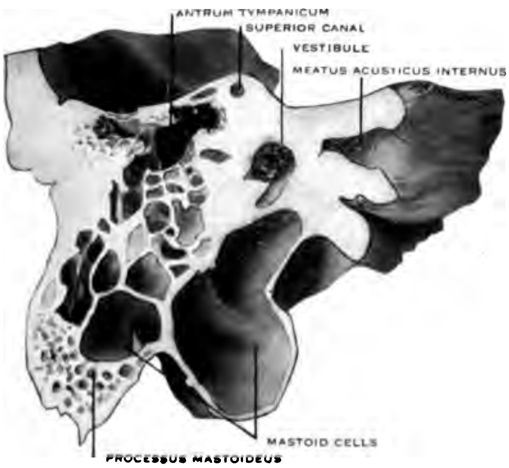


Fig. 88.

Fig. 89.

Figs. 88 and 89. Section through temporal bone. Section passes through antrum, vestibule and internal meatus. Large pneumatic cell developed internal to the digastric groove. (Anatomic variation.)

over the outer surface of the mastoid and in the second place such a cell might readily escape detection when operating on the mastoid

process. The mastoid cells all communicate with the antrum and although the walls separating adjoining cells usually show dehiscences cells may retain their own openings leading to the antrum. In this way it is possible for a large cell at the tip of the mastoid to communicate with the antrum through its own channel and without communicating with adjoining cells. This condition may explain the occurrence of an isolated abscess in the tip of the mastoid process.

The process of pneumatization of the mastoid is often incomplete so that mastoid cells are formed in but a part of the mastoid. In such cases the cells are located close to the antrum while the tip of the process and the posterior margin are free from air cells. (Figs. 80, 90, 91.)

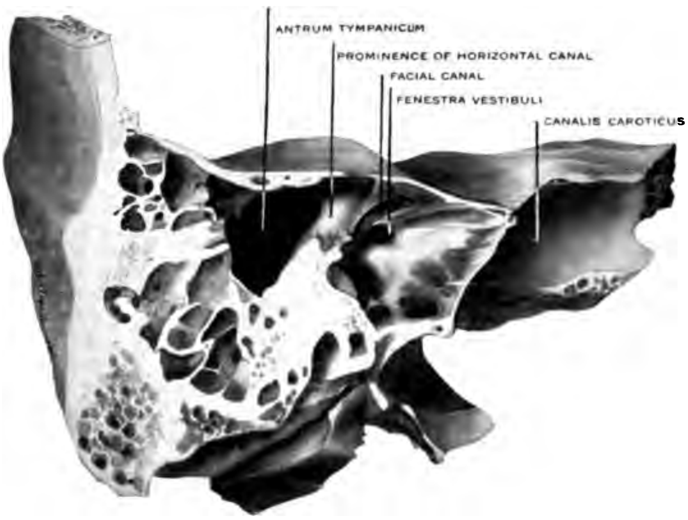


Fig. 90.
Section through temporal bone, showing relation of the horizontal canal and facial canal to the middle ear chambers; also relation of the carotid and bulbar jugularis to the cavum tympani.

In other cases no mastoid cells whatever exist. (Figs. 92 and 93.) Here the process is flatter and smaller than normal and the size of the antrum also is quite small. In other words the whole impression one gets from an examination of this type of mastoid is that of an undeveloped infantile condition. It is this type of mastoid process that is found in cases of chronic suppurative otitis media dating from early childhood. Mr. Cheatle interprets these facts as indicating that cases of acute purulent otitis media are more inclined to become chronic when occurring in the non-pneumatic type of mastoid. Others are inclined to believe that the lack of pneumatization in such cases is itself the direct result and not the cause of the chronic suppuration. The suppuration beginning in early childhood before the development of the mastoid

has progressed very far hinders its further development; the result being these cases of complete absence of mastoid cells. This condition

Fig. 91.
Section through the mastoid process, showing but partial pneumatization. A few small mastoid cells near the antrum are all that have formed.

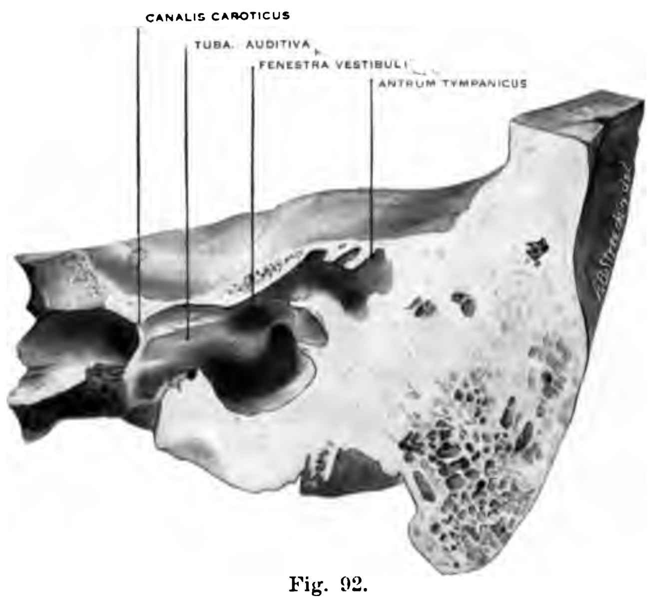


Fig. 92.
Diplœtic type of mastoid. Complete absence of pneumatic spaces. Antrum tympanicum contracted.

should not be confused with the process of osteosclerosis or hardening of the bone surrounding as a rule a cholesteatoma formation in the an-

trum. The roof of the mastoid is a thin shell of bone which separates the antrum and the mastoid cells from the middle brain fossa. Over the antrum it is called the tegmen antri. Dehiscence in the bone frequently exists so that only the lining of the mastoid cells and the dura separates the cells from the brain cavity. (Figs. 77, 90, 94, 95.)

A number of important structures come into close relation with the mastoid process. The sigmoid curve of the lateral sinus lies internal to this process and encroaches more or less on spaces of the mastoid. (Fig. 82.) The distance separating this sinus from the posterior wall of the external meatus varies in different individuals. Usually there is ample space between the sinus and the posterior wall of the meatus to permit of a wide opening into the antrum. In other cases the sinus lies so close to the meatus wall that the opening into

Fig. 93.

Section through adult temporal bone, showing persistence of infantile type with absence of pneumatic spaces in the mastoid. The relations of the horizontal and facial canals to the middle ear spaces.

the antrum has to be made by working along the upper posterior wall of the meatus instead of posterior to the suprametal spine. The location of the sigmoid curve is usually the same on both sides. The important relation of the facial canal to the mastoid has already been discussed. It is important to remember that mastoid cells may develop in close proximity to the facial canal and that these cells may lie deeper than the facial, that is internal to it. The facial nerve is most readily injured in its course through the tympanum or at the point where it makes the bend downward toward the stylomastoid opening. (Figs. 77, 80, 81, 90, 92, 94.)

The horizontal semicircular canal forms a prominence in the floor of the antrum where its hard ivory-like capsule can readily be recognized, when opening the antrum, by its smooth glistening appearance. Its position is such that should the cavity of the antrum be mistaken

for a mastoid cell a single stroke of the chisel in an attempt to penetrate further might readily open the canal. Its position in a measure protects the facial nerves from injury when operating on the mastoid, for its hard capsule forms a partial covering for the facial canal just back of the oval window. (Figs. 80, 90, 94, 95.) The superior semicircular canal encroaches at times on the anterior inner wall of the antrum. (Fig. 96.) In antrum disease it is possible for an erosion into the superior canal to occur. This canal is not exposed to injury in operating on the mastoid as is the horizontal.

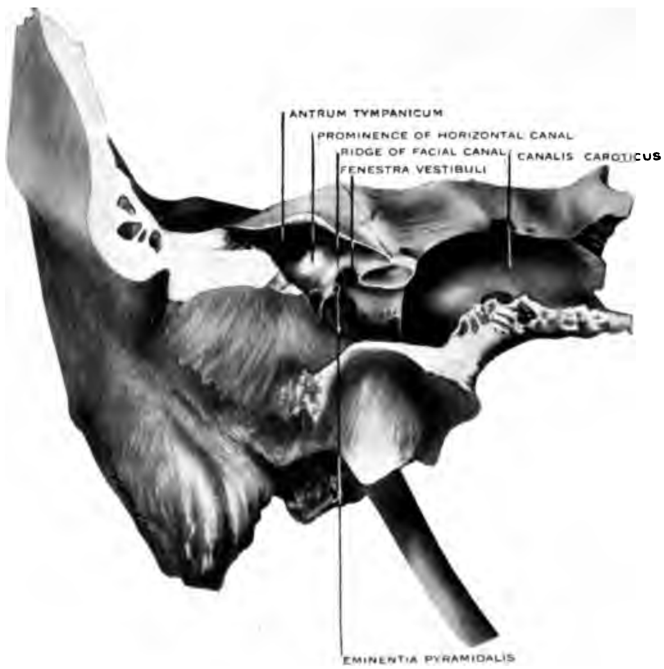


Fig. 94.

Section through adult temporal bone, showing the relations of the carotid to the cavum tympani and the structures in the floor of the recessus epitympanicus.

Cavum Tympani.

Anatomically the tympanic cavity forms but a part of a larger cavity which includes the antrum tympanicum and the passage between these two, the recessus epitympanicus. (Figs. 80-95.) Pathologically also these chambers should be considered together as they are usually involved in the same process. The division of the passage way from the tympanum to the antrum into two parts, an attic and aditus, is not feasible anatomically. (Fig. 95.)

The inner wall of the tympanic cavity is formed largely by the capsule of the labyrinth. The first turn of the cochlea produces a

prominence just posterior to the center to which the term promontory is given. Just above the promontory is an oval opening into the vestibule of the labyrinth called the fenestra vestibuli. This is the oval window in which the foot plate of the stapes is attached. The window itself is at the bottom of a depression out of which only the head of the stapes and a small part of the cruræ project. Just posterior to the promontory, lying but a couple of millimeters from the oval window, is the opening into the first turn of the cochlea called the fenestra cochleæ. This is the round window covered over by a membrane which separates the tympanum from the scala tympani. Directly posterior to that part of the promontory which separates the oval from the round window is a depression often extending under the canal for the facial

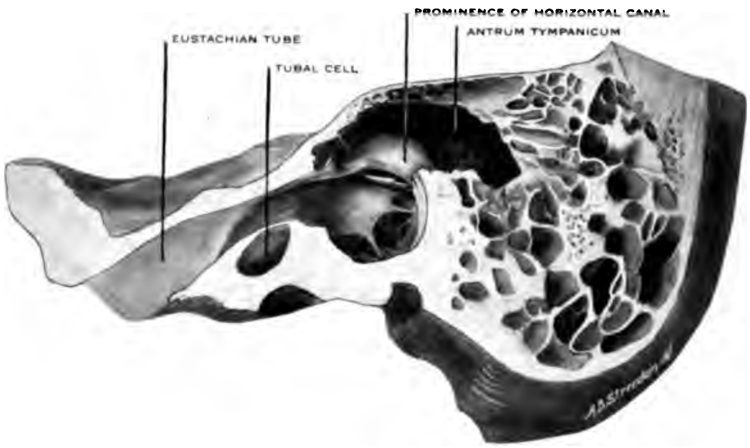


Fig. 95.
Section through mastoid, cavum tympani, tuba auditiva, showing a large tubal cell.

nerve. This depression is known as the sinus tympanicus. It is difficult to smooth out this pocket when performing the radical mastoid operation. A conspicuous marking on the inner wall of the tympanum is the canal for the tensor tympani muscle. This lies just above the tympanic orifice of the Eustachian tube. The processus cochleariformis which forms the posterior end of this canal projects out a short distance over the anterior margin of the oval window. (Fig. 94.) The relation of the facial canal to the inner wall of the tympanum is of great surgical importance as the facial nerve in its course through the tympanum is covered by an extremely thin delicate covering of bone which can readily be fractured by the use of a curette. The nerve enters the tympanum in front of and just above the oval window. Its course is more or less horizontal until just posterior to the oval win-

dow it curves downward toward the stylomastoid opening. (Figs. 80, 81, 90, 93, 94, 96.) The prominence formed by the horizontal semicircular canal in the floor of the passage from the antrum into the tympanum projects out beyond the facial canal and in this way serves often to protect the nerve from injury when operating in this region.

The roof of the tympanum is formed by a plate of bone separating this cavity from the middle fossa. This is called the tegmen and is often extremely delicate. (Figs. 77, 80, 90, 94, 95, 98.) In the new-born it is crossed by the suture between the squamos and petrous bones through which blood vessel communications extend between the dura and the membrane lining the tympanum. Through this tegmen sup-

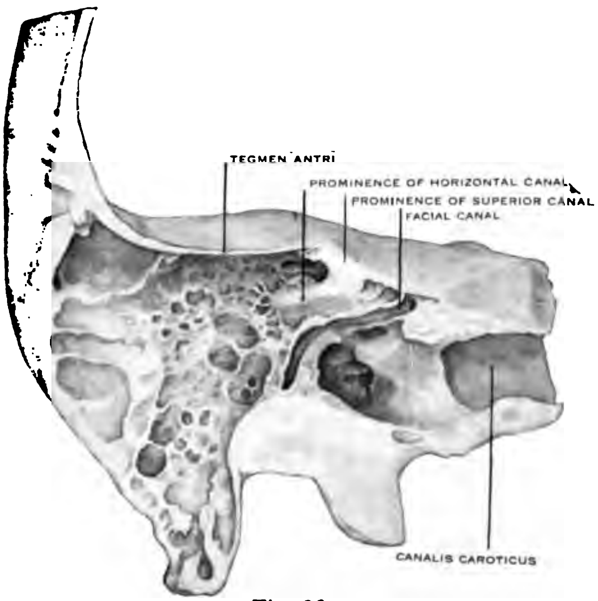


Fig. 96.
Section through the mastoid and tympanic cavity, showing the relation of the horizontal and superior canals to the antrum.

purative disease in the tympanum frequently penetrates into the brain cavity.

The floor of the tympanum contains a number of depressions called tympanic cells. These cells are occasionally quite extensive in which case it becomes difficult if not quite impossible to clean them out entirely in operating on the tympanum. (Fig. 97.) The floor of the tympanum extends somewhat deeper than the floor of the external meatus. This depression is called the recessus hypotympanicus. The relation of the bulb of the jugular to the floor of the tympanum is such that infection occasionally extends from the tympanum directly to the

bulb. The bulb is frequently exposed to injury when curetting the floor of the tympanum. In most cases the bulb is separated from the tympanum by a thick wall of bone. (Fig. 90.) In other cases the bulb forms a prominence in the floor of this cavity. It is then covered by an extremely thin shell of bone readily broken by the curette. (Fig. 98.)

In the anterior wall of the tympanum is located the tympanic orifice of the Eustachian tube. (Figs. 82 and 95.) The internal carotid lies directly in front of the tympanum from which it is separated by a thin plate of bone. (Figs. 80, 82, 90, 94.) In performing the radical mastoid it is important to remember that the carotid lies below, that is internal to the Eustachian tube. In order to avoid injuring this vessel the pressure of the curette in the mouth of the tube must be directed upward, that is outward. The mesial wall of the tube should not be

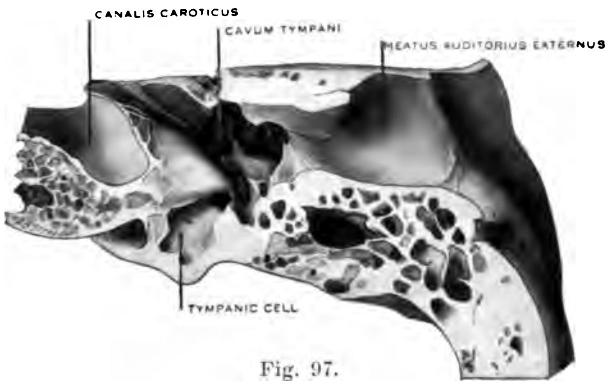


Fig. 97.

Horizontal section through the temporal bone seen from below. A large tympanic cell developed near the floor of the tympanum.

curetted. Pneumatic cells are frequently found opening into the Eustachian tube near the tympanum. These are the tubal cells and at times they are quite extensive. (Fig. 95.) On account of the relation of the internal carotid it is often not feasible to eradicate these tubal cells when performing the radical mastoid operation.

In the posterior wall of the tympanum is located the opening into the antrum. (Figs. 94 and 95.) This opening occupies about the upper third of the posterior wall. The canal for the facial nerve forms a slight prominence along the mesial wall of this opening. (Figs. 90 and 94.) At the lower margin of the opening the facial canal enters the posterior wall of the tympanum. Toward the floor of the tympanum this canal recedes more and more from the posterior wall of the cavum tympani. (Figs. 80 and 81.) A small bony prominence just back of the oval window contains an opening for the transmission of the tendon of

the stapedius muscle. This prominence is called the eminentia pyramidalis. (Fig. 94.) The depression in the posterior wall of the tympanum, called the sinus tympanicus, lies directly under the eminentia pyramidalis.

The external or outer wall of the tympanum is formed chiefly by the membrana tympani. At the floor of the tympanum is a depression, the recessus hypotympanicus, the external wall of which is formed by the floor of the bony meatus. (Fig. 76.) At the upper part of the tympanum is the recessus epitympanicus, the outer wall of which is formed by the bone forming the roof of the external meatus. (Fig. 76.) In

Fig. 98.

Section through temporal bone, showing relation of the bulbus jugularis to cavum tympani and relations of the cochlea and facial canal to the cavum tympani.

removing the external wall of the so-called attic, there is danger of injuring the facial nerve as this structure in its course through the tympanum lies directly internal to the lower margin of the external wall of this chamber.

When curetting out the tympanic cavity great care must be taken on account of the danger of injuring important structures. In the floor of the tympanum is the recessus hypotympanicus and the tympanic cells which frequently require cleaning out when performing the radical operation. Here the danger of injuring the bulb of the jugular must be kept in mind. Along the posterior wall of the tympanum are several depressions, the largest of which, the sinus tympanicus, extends often under the canal for the facial. These cells are

exposed only by removing the ledge of bone in front of the facial canal in the lower half of the posterior wall of the meatus. (Figs. 80 and 81.) In the floor of the Eustachian tube near its tympanic orifice are the tubal cells, which must be opened with great caution on account of the location of the internal carotid just anterior and internal to the tympanum and internal to the Eustachian tube. The roof of the tympanum, the tegmen tympani, separates this cavity from the middle fossa. It is a fragile shelf of bone easily perforated by a curette. In curetting the inner wall of the tympanum the region just below and in front of the prominence for the horizontal canal should be avoided because the facial canal crosses the tympanum here and in this region is the oval window with the stapes. A dislocation of the latter may lead to an infection of the labyrinth.

The relations of the lateral sinus are important to keep in mind not only when operating on the sinus itself but whenever an opening into the mastoid is made. The variations in the location of the sigmoid curve of this sinus are such that unless they are understood there is often great danger of opening the sinus when performing the simple mastoid operation. The sigmoid usually lies far enough posterior to the external meatus to permit of a free opening into the antrum. (Fig. 82.) It frequently projects forward, however, so close to the posterior wall of the external meatus that a free opening from the surface of the mastoid into the antrum is obstructed. It usually lies at a considerable distance from the surface of the mastoid but in those cases in which the sinus is pushed forward it approaches closer and closer to the surface of the mastoid. It can be seen in some cases after the periosteum has been removed, as a bluish discoloration from the surface of the mastoid. In all cases the cortex of the mastoid should be removed with caution until the location of the sinus has been determined. In rare cases there is a congenital absence of the lateral sinus on one side. The author has one such preparation in his collection. Near the upper posterior margin of the mastoid process the sinus takes a horizontal direction backward. At about the level of the floor of the tympanum the sinus turns inward and somewhat forward in a horizontal direction towards the bulb.

The position of the bulb of the jugular and its relation to the surrounding structures must be understood by the surgeon who undertakes to operate on the mastoid. In cases of infection it becomes necessary to expose the bulb and to lay it freely open. The relation of the bulb to the cavum tympani has already been described. When the bulb occupies that relation to the floor of the tympanum which is shown in

Fig. 98 or in Fig. 90 an exposure of the bulb by operating through the tympanum is feasible.

The location of the bulb varies, however, even more than does that of the lateral sinus. In most cases the bulb makes but a shallow indentation in the lower surface of the temporal bone, so that a curette passed forward along the lateral sinus will remove clots located in it. In these cases it is separated from the floor of the tympanum by a thick layer of bone. In other cases the dome of the jugular bulb is pushed upward higher and higher along the posterior wall of the petrous bone. In these cases the appearance is not unlike an erosion produced by an eddy in a stream. The extent to which the bulb is pushed upward in these cases is often surprising. Occasionally the bulb extends to the highest margin of the petrous bone. In Fig. 100 is shown a case in which the bulb extends through the superior margin of

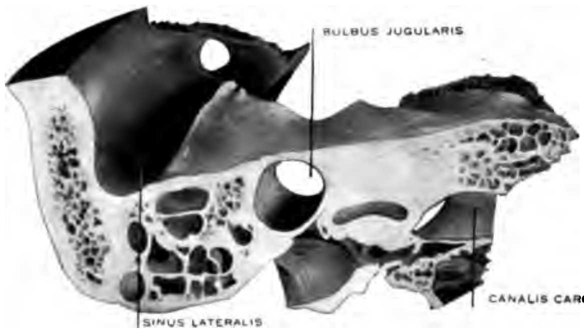


Fig. 99.
Horizontal section through the temporal bone seen from above, showing the relations of the bulbus jugularis to the lateral sinus.

the petrous bone and in its course obliterates part of the posterior wall of the internal meatus as well as the bony covering of the aquæductus vestibuli.

The surest route for the exposure of the jugular bulb is to follow along the course of the lateral sinus until the bulb is reached. By chiseling along in front of the sinus a layer of bone can be removed posterior to the facial canal which will usually permit of a more or less free exposure of the bulb, depending, of course, on whether the bulb is shallow or deep. The thickness of the bone that can be removed in this way along the anterior wall of the sinus without an injury to the facial nerve is often as much as 0.5 cm. (Fig. 99.) Care must be taken in making this opening into the bulb not to extend the chiseling too far up along the posterior surface of the petrous bone for here there is danger of opening into the posterior semicircular canal.

In connection with the surgical relation of the lateral sinus it should be mentioned that this structure serves as the best guide for the opening of a cerebellar abscess. These abscesses lie usually somewhere along the posterior surface of the petrous bone in front of the lateral sinus. To attempt to drain such an abscess by an opening back of the sinus is more difficult because of the great distance from the surface. The best route by which to reach these abscesses is by making an opening in front of the lateral sinus. If the anterior wall of the lateral sinus is followed and the chiseling is not carried too far forward it is possible to expose the cerebellum without an injury of the posterior semicircular canal provided that the abscess is not secondary to a labyrinth suppuration.

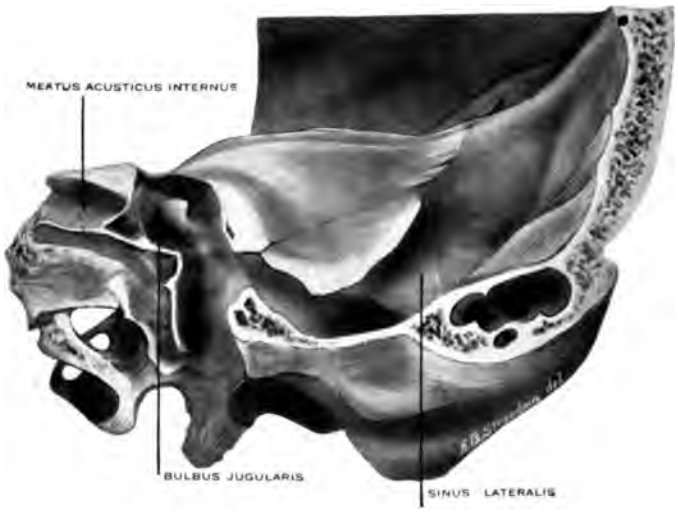


Fig. 100.
View of the posterior aspect of the temporal bone, showing bulbus jugularis extending to the upper margin of the petrous bone. (Anatomical variation.)

The surgical anatomy of the labyrinth is best explained in connection with the operation on the labyrinth. In this connection attention may be called to the relations of the labyrinth to the middle ear chambers. In the cavum tympani the capsule of the labyrinth is freely exposed. The promontory on the inner wall is formed by the large turn made by the beginning of the basal coil. By chiseling from the lower edge of the fenestra vestibuli a free opening into the vestibule is made and in removing the promontory free drainage of the cochlea is accomplished. In removing the promontory the relation of the bulb of the jugular shown in Fig. 98 should be kept in mind. In just such a case the author has opened the bulb while removing the

promontory. The apex of the cochlea can be exposed by chiseling forward from the anterior margin of the oval window. The apex of the cochlea lies internal to the tympanic orifice of the Eustachian tube. Its relation to the internal carotid lying just posterior or external to this structure makes it necessary to exercise great care when working in this region.

Two of the semicircular canals come into more or less close relation to the middle ear cavities, the horizontal and the superior. The capsule of the horizontal canal forms a white glistening prominence readily seen in opening the antrum. It lies in the floor of the recessus epitympanicus at the point where this opens into the antrum. The relation of the superior canal to the middle ear is not nearly so intimate. It lies just above the anterior end of the exposed part of the horizontal canal. In this way its anterior crus is readily exposed by chiseling above the prominence of the horizontal canal and directly over the oval window. In opening this canal the position of the facial nerve along the upper margin of the oval window must not be forgotten. The posterior semicircular canal does not come into close relation to the middle ear. It can be reached by removing the triangular piece of bone between the superior and the horizontal canals.

CHAPTER IV.

EXTERNAL OPERATIONS ON THE LARYNX, PHARYNX, UPPER ESOPHAGUS, AND TRACHEA.*

By George W. Crile, M. D.

Special Difficulties and Dangers.

The technic of external operations upon the upper air passages and the esophagus would be simple enough were it not for certain special difficulties and dangers peculiar to these operations. It is well therefore to first consider these, that the full significance of the various steps of the operations to be described later may be more fully appreciated.

Pneumonia.—Pneumonia following operation on the upper air passages is due in most instances to one of two causes: (a) the inhalation of blood or mucus, and (b) the inhalation of infected wound discharges. These injurious inhalations occur usually in the course of the operation, although occasionally the postoperative oozing is inhaled. These dangers may be prevented in part by scrupulously maintaining a dry field during the entire course of the dissection. This is accomplished by picking up every vessel large enough to be considered at all, either before dividing it or immediately after it had been divided. In this manner the field will be kept so clear of blood that all anatomic structures may be easily seen and identified. During the later stages of the dissection the vessels which have been picked up may be ligated with either light catgut or light silk. While this manner of dissection may at first seem to be tedious, it will in the end prove the quickest method, and is the method of choice in dissections for the exposure of the larynx, pharynx, trachea, or esophagus. When the field of operation has been reached, however, the prevention of blood inhalation becomes quite a different problem, because the blood supply of the mucous membrane is maintained principally by terminal arterioles which cannot be effectively controlled by ligation. At this point in the operation one of two courses may be adopted. The patient may be placed in a head-down, inclined posture at such an angle that the blood will gravitate away from the lung; or by the hypodermic use of novocain and adrenalin the trachea, the larynx,

*Operations within the larynx through external incisions will be considered in the chapter on endolaryngeal operations.

and the pharynx may be entered without resultant coughing or material oozing. If the mucous membrane has been locally anesthetized the bleeding may usually be controlled by the local application of pledgets of cotton saturated with adrenalin pressed firmly against the bleeding points by hemostatic forceps. The further control of hemorrhage depends upon the circumstances of the individual operation. If conditions permit, a rubber tube which snugly fills the trachea or even distends it will entirely control the dangerous factor of blood inhalation.

There are both advantages and disadvantages to the control of hemorrhage by posture, for the amount of hemorrhage, especially of venous hemorrhage, is increased by gravity. Then too, the head-down position is less favorable for the operator. The direct control method has the advantage of light, accessible position and the minimum bleeding. The author has rarely found it necessary to resort to the head-down posture, although it has sometimes been temporarily used during some phase of an operation. Occasionally, of course, a great emergency may exist in which the head-down posture is urgently demanded.

Local Infection.—The next great danger associated with operations on the upper respiratory tract is that of local infection, for it may happen that after the air passages have been opened a serious local infection will spread over the contiguous territory and along the deep planes of the neck. The occurrence of some infection must be taken for granted, but it is for us to consider by what means the amount and the virulence of the infection may be diminished and how it can be localized. In the first place, the danger may be minimized in advance by canvassing all of the contiguous territories and making sure that there are not present any active foci of infection, such as decayed teeth, pyorrhea, alveolar abscesses, discharging sinuses, peritonsillar abscess, pharyngitis, or purulent rhinitis. At the time of the operation itself we may control the local severity of the infection by using only sharp dissections and by minimizing to the utmost the trauma of surrounding tissues; by leaving no oozing of blood; by making careful decisions as to the immediate closure of the soft parts overlying the wound; and by using iodoform packing if there must be any wound in the soft parts of the throat and neck. When infection has been inaugurated there are no better therapeutic measures than the hot pack and the inhalation of medicated or plain steam.

Mediastinal Abscess.—After pneumonia, mediastinitis and mediastinal abscess have been the most fatal after results of the operations we are considering. The onset of infection is usually a week or ten days after the operation, and is characterized by a steeple-

chase temperature, not high, and always remitting in the morning. There is usually but little pain, and the course of the disease is toward slow, but certain death. In many respects it resembles the retroperitoneal abscesses which also come late, are almost painless, progress slowly, show a steeplechase, but low temperature curve, and end usually in death. The explanation of the characteristic, painless, tedious and fatal course of mediastinal abscess is probably found in the fact that this region of the body has always been protected from wounds by the bony chest wall. Being closed to wounds through the vast periods of man's evolution, it has been closed likewise to infection. The tissue of this protected region, therefore, has not been endowed with the elements required to efficiently meet and overcome infection as have been, for example, the peritoneum and the external parts of the body. In view of this fact, we must guard this helpless territory with special care.

As we have shown that preoperative measures may in large degree prevent the extensive course of local infection, so the danger of mediastinitis may be guarded against by preoperative protection. If in the course of a laryngectomy, for instance, the divided trachea is stitched to the skin, there is great danger that subsequent coughing will cause it to become detached. Its moorings having been lost, it will be thrust back and forth, in and out of the thoracic box, like the piston of an engine. Mediastinal infection will be the almost inevitable result. If, on the other hand, the free end of the trachea is not fixed by sutures, but is held by gauze packing about it, then the trachea will retract within the thoracic cage like the head of a turtle, and again infection must result. It is obvious, then, that the trachea should be so fixed by preliminary operation that there may be produced an invincible barrier of granulations extending across the base of the neck and the entrance to the thoracic cage. There are two methods by which this may be done: The ordinary simple tracheotomy will fix the trachea and will stimulate the formation of efficient granulation tissue; or exposing the trachea and the lower larynx and packing the lateral planes of the neck with iodoform gauze will result in the production of granulations and in fixing the trachea so firmly that coughing cannot break its moorings. Each of these methods of itself alone has certain advantages and disadvantages. The simple tracheotomy is not so certain a safeguard against infection of the mediastinum as is the latter method, and it does not result in so firm a fixation of the trachea in the deeper part of the neck; but it has the advantage of establishing a strong defense mechanism in the mucous membrane of the trachea itself. On the other hand, the packing of

the deep planes with iodoform, while otherwise an ideal protection, does not supply the protective defenses in the mucous membrane of the trachea. An ideal defense, then, is found in a combination of the two operations, that is, in opening and packing the deep planes of the base of the neck, and at the same seance making a low tracheotomy. By this means the mediastinum is put under strong guard, and at the same time the later technic of the operation is measurably reduced.

Vagitis.—Though a less frequent risk than those we have described, vagitis represents a formidable and special danger. In the course of the convalescence following laryngectomy, usually after the fourth day, a group of new symptoms is occasionally introduced; the pulse becomes very rapid and irregular in rate and rhythm—it may jump from 90 to 140 in a few minutes; the heart's action becomes tumultuous at times; the patient is quiet or perhaps a little apprehensive. Death from vagitis has been reported, though in the author's cases the symptoms passed after a rather boisterous course of a few days. It is probable that the trunks of the vagi have become involved in the wound infection and as a result these nerves have been rendered unfit to properly conduct stimuli. Hence there arises the striking conflict between the vagus and the accelerator control, the picture being very similar to the immediate effect of crushing or dividing both vagi simultaneously. As a protection against this, one might utilize the well-known physiologic fact that the division of one vagus causes no notable change in the heart's action. In the course of extensive dissections for the wide excision of cancer of the neck, the author has eight times excised a portion of the trunk of one vagus. Close observation of the pulse and respiration detected no change nor was any later alteration observed. Following this indication, then, at the preliminary operation one should carry the dissection on one side of the larynx all the way to the upper margin of the field of final operation, and should pack this territory with iodoform gauze just as the deep planes of the neck are packed. By this procedure one vagus must take the brunt of exposure and adjustment before the larynx is removed. By the time the laryngectomy is done this vagus would be readjusted and ready to resume its function in case it was affected at all, and so the heavy onslaught of the vagi upon the heart would not be made by both vagi simultaneously. In the case in which the author tried this plan it seemed to be completely effective. When vagitis has become established there is little that can be done to alleviate it, although hot applications are apparently of some service.

Reflex Inhibition of the Heart and Respiration Through Mechanical Stimulation of the Superior Laryngeal Nerves.—This is a

minor phenomenon peculiar to the surgery of this region, but it is reported to have resulted in several deaths and has caused much anxiety and trouble to those who have never known of its existence and who have not known how to interpret and obviate it. In a laryngectomy the terminals of the superior laryngeal nerves in the larynx and on the surface of the rima glottidis are of necessity disturbed, and the trunks of these nerves are divided in the course of operation. The function of the laryngeal nerves is the protection of the pulmonary tract from the entrance of foreign bodies. The slightest touch of their endings, therefore, causes a cough reflex, and a strong contact will cause an inhibition of respiration and of the heart. The nerve supply of the trachea has no such function, but the area of distribution of the inhibitory nerve endings extends over a part of the pharynx and a part of the posterior nares even. Fortunately, we have an absolute protection against this dramatic and sometimes dangerous phenomenon, in the hypodermic administration of 1/100 grain atropin (adult dose) before the operation. In addition a spray, a local application, or the local hypodermic injection of novocain will control absolutely the inhibitory reflexes.

Selection and Care of Tracheal Cannula.—The last special difficulty which we shall consider relates to the after-care of the patient, and refers to the selection and care of the tracheal cannula. After trying many kinds of cannulæ, the author has found that the common male or female curved cannula, or plain rubber tubing even, will answer all purposes. The greatest care should be exercised in adjusting the metal tubes so as to prevent pressure necrosis. Rubber tubing is preferred by some patients, but the metal tubes usually are best. A rubber tube drawn over a metal tube is perhaps the easiest to wear, but the author has found that patients become careless by their familiarity with danger and will wear loose-fitting tubes. This point was strongly impressed on the author by the difficulty once encountered in extracting a rubber tube that had slipped off the metal tube and had been carried deep into the trachea. After a stormy session in which the patient almost suffocated, the tube was caught by groping deep within the trachea with a curved hemostat forceps and it was extracted while the patient was unconscious from asphyxia. In time all laryngectomy cases get along without tubes. In fact, in recent cases the author has been able to dispense altogether with tracheal tubes, both at the time of the operation and ever afterward, and the author's patients have all preferred to get along without phonating apparatus.

Operations on the Trachea.

Tracheotomy.—A tracheotomy may be high or low, an emergency or a planned operation. There is but little difference between the technic of the high and the low tracheotomy, but there is a vast difference between planned and emergency operations. The latter will therefore be described separately.

Emergency Tracheotomy.—Foreign bodies in the larynx or trachea, the pressure of tumors, the closure of the trachea by the swelling of previous strictures, the pressure of an abscess, the encroachment of malignant tumors of the thyroid or other tissues, the closure of the larynx by intralaryngeal tumors, at first gradual but finally sudden, and many other causes of obstruction may demand an emergency tracheotomy. Then, too, the trachea may collapse during the removal of a large obstructing goitre—especially if the operation is being performed under ether anesthesia. Whatever the cause, this emergency presents one of the most dramatic of surgical crises. Under the urgent necessity, it is usually a laryngotomy and not a tracheotomy that is performed. But in the presence of an emergency when a life is flickering fine distinctions are lost.

In emergencies which occur in the course of operations upon patients who are laboring against respiratory obstruction there are several very important points to be considered in the effort to prevent respiratory collapse. First, the patient must be kept free from excitement,—by morphin and atropin if personal influence be insufficient. Under excitement respiration is accelerated. The resultant increase in the exchange of air at once accentuates the diminished space at the constriction and makes the patient feel acute symptoms of suffocation, whereas quiet breathing can be accomplished easily through a smaller aperture. Second, a little mucus may precipitate respiratory obstruction. Happily, the secretion of mucus may be wholly controlled by the use of atropin. Third, a general anesthetic is absolutely contraindicated when a patient is exerting more than the normal muscular action in effecting an exchange of air, especially when he is using the extraordinary muscles of respiration. The author has seen instances of the fatal error of giving a general anesthetic to such a patient. Inhalation anesthesia paralyzes the extraordinary muscles of respiration. These muscles are used only when enough oxygen to sustain life cannot be secured by the action of the ordinary muscles of respiration. Under these circumstances therefore the extraordinary muscles become vital.

Therefore, in cases of respiratory obstruction in which the extraor-

dinary muscles of respiration are used, the operation must be performed under local anesthesia—and if by chance there is no local anesthetic available it must be done without anesthesia of any kind.

The ideal state for operation in the presence of partial obstruction is the general quiescence produced by morphin, local anesthesia being secured by the use of novocain. When an emergency tracheotomy is to be performed, it is best to put the patient quickly in the Trendelenberg posture so that the bleeding, which under the influence of asphyxia is sure to be increased, may not be inhaled and cause a septic bronchitis or pneumonia. In emergencies the probability of blood inhalation is so great that the patient should at once be placed in the Trendelenberg position. The trachea should not be opened by a plunging incision, a procedure which has brought many a promising attempt to grief. An orderly but accelerated dissection whereby the operator may distinctly see the tracheal rings yields the quickest relief even in the hands of master surgeons—indeed it is by performing controlled operations that one becomes a master surgeon. As soon as the trachea has been perforated nothing but bad technic can cause the patient to suffocate. If the soft parts are sufficiently retracted by instruments or fingers or both so that the blood is kept out, the patient will do all the better. As for the tracheotomy tube any piece of rubber tubing will answer. In the absence of rubber tubing or tubing of any sort the tracheal rings may be stitched to the skin on each side. After an emergency opening of the trachea which has been performed under the partial anesthesia of asphyxia, the patient will rapidly revive under a normal supply of oxygen though his suffering will be great. Morphin should therefore be given as quickly as possible. In the management of the excited patient upon whom an emergency tracheotomy is performed it is important to take extraordinary care to prevent further excitement or further pain. Such a patient needs rest and quiet to regain normal composure.

Planned Tracheotomy.—The selection of the position for a tracheotomy depends entirely upon the condition for the relief of which the operation is to be performed. Technically, indeed, two considerations might seem to influence the choice of the position of the opening. The upper portion of the trachea is the most accessible, but at this point the thyroid renders the dissection difficult; in the lower portion of the trachea the thyroid does not interfere with the dissection but here the trachea is much more deeply situated in the neck. In a controlled operation, however, neither the thyroid above nor the deep position of the trachea below need interfere with the selection of that point which will best serve the purpose of the tracheotomy. A trans-

verse incision through the skin leaves the best ultimate scar,—an important consideration. It is an interesting fact that, since folds and creases are normally transverse or oblique, a vertical scar at once fixes the attention, while a greater scar even is unnoticed if it be placed obliquely or transversely. A transverse skin incision presents but little more technical difficulty than an ample vertical one. A con-

Fig. 101.
Tracheotomy under local anesthesia; novocainizing the skin.

trolled technic so easily surmounts this obstacle that the patient should whenever possible be given the advantage of the transverse incision.

The patient is first placed in a quiet and apathetic condition by means of a moderate dose of morphin or of morphin and scopolamin. No inhalation anesthetic is used.

The skin and subcutaneous tissues are infiltrated with 1/400 solution of novocain. (Fig. 101.) The area of infiltration is put under immediate pressure to extend the anesthetic field. In dividing the tissues sharp dissection only is used and the field is kept clear and translucent by dividing the vessels between forceps or, when this is impossible, by clamping them immediately after their division.

The wound should be retracted as lightly as possible. If the line of incision necessitates the division of the thyroid the same bloodless dissection should be made. If the lateral lobes of the thyroid are fused in the median line the gland may be grasped in forceps on each side of the proposed line of incision and divided. (Fig. 102.) After complete division of the thyroid the cut margins may be secured against

Fig. 102.
Tracheotomy. Incision through thyroid gland and trachea.

bleeding by the insertion of button hole stitches with a curved needle. When the trachea is freely exposed it is carefully infiltrated with novocain—first, the superficial layers, then gradually and slowly the deeper parts of the tracheal wall,—care being taken not to allow the needle (which should be a fine one) to penetrate beyond the advancing zone of infiltration. The needle point should always be in anesthetized tissue so that the tracheal wall, including the keenly sensitive mucous membrane, may be anesthetized without causing a single cough. The addition of adrenalin to the novocain solution makes possible the opening of the trachea without pain and with little or no oozing. The prevention of oozing is an important point, first, because blood should be scrupulously excluded from the trachea as a pro-

tection against subsequent infection; and second, because the trickling of even a drop of blood down into the trachea will incite violent coughing and the strain of the coughing will in turn increase the oozing because of the increased blood pressure caused thereby. This increased oozing again causes still more coughing and so a vicious circle is established. Such a vicious circle cannot well be immediately broken by sponging the blood because of the violent motion of the coughing, and the sponge by touching the anesthetized tissue of the trachea will set up more coughing and hence defeat its purpose. If in spite of pre-

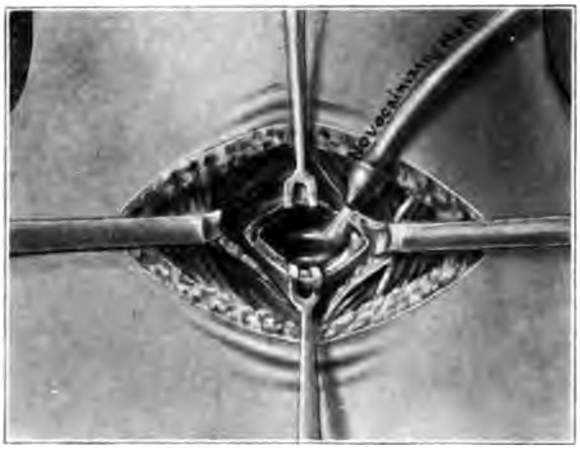


Fig. 103.
Tracheotomy. Novocainizing the trachea from within.

cautions oozing into the trachea does occur one can only wait until an adjustment takes place and the patient becomes quiet.

In dividing the trachea the operator may choose between a transverse division between the tracheal rings, or a vertical division passing through the rings. The transverse incision closes more readily than the vertical but it does not offer quite so free an opening. Tracheotomies performed for temporary purposes, therefore, should be transverse; but for the long continued use of a tracheal tube—especially if the tube is to be handled by inexpert hands, the vertical incision is better.

As soon as the trachea is opened the mucosa should be anesthetized with a two per cent solution of novocain. Meanwhile the trachea is held open with such an instrument as a small single hooked tenaculum to provide for an abundance of air. (Fig. 103.)

The technic of the low tracheotomy is the same as that for the

high tracheotomy. It may be well to mention two rather surprising facts, however, the extraordinary depth of the trachea low in a thick neck, a depth which apparently increases in a restless patient, and the astonishingly extensive excursion of the trachea in the act of coughing.

In this connection one sees a remarkably beautiful dynamic adaptation in the contraction of the various muscles of the neck to prevent rupture of the pleura. Were it not for the strong protection offered by the neck muscles the pleura at the apices would surely be ruptured.

Tracheal Tube.—Among the many types of tracheal tubes the standard curved metal cannula consisting of an inner and an outer tube—gives the best service. (Fig. 104.)

An albolene or other oil spray applied to the tracheal mucosa is an added protection against secretions and against too much drying

Fig. 104.
Tracheotomy. After the operation.

of the air which is now deprived of the moisture and perhaps warmth that it gains in passing through the upper air passages in normal breathing. At all events the liberal use of an oil spray not only adds to the comfort of the patient but also reduces the tendency to dessication of small masses of mucus in the neighborhood of the tracheal tube.

After-care of the Patient.—The highly efficient after-care of tracheotomy patients is indeed a difficult achievement. There is an enormous difference between the efficiency of a nurse after experience in the care of tracheotomy cases and in her first case. It is well to specialize such work. For the proper care of her patient the nurse

requires a supply of feathers trimmed down in such a manner that the inner tube may be promptly cleared of mucus as soon as the peculiar mucus noise is heard. At first the patient tends to become panicky whenever any mucus obstruction exists, and the inexperienced nurse may share the patient's apprehension,—surely an unhappy atmosphere. The experienced nurse learns to manage the mucus so that there is only an occasional necessity to remove and cleanse the tube.

The first removals of the tube should be done by the surgeon since the excitement and the coughing may cause a certain amount of obstruction which may throw the patient into a panic. Under these conditions the effort to replace the tube may increase the obstruction, cause bleeding, disturb the local field and so do much harm. Until the granulations produce a living mould of the tube and thus guide it to its place it is best in replacing the tube to use a pair of slender retractors—by means of which the opening in the trachea may be brought into view. The tracheotomy tube will then readily drop into place.

The air of the patient's room should be kept evenly warm and moist and may be medicated by vaporizing pine needle oil. The moist air and a piece of gauze moistened with salt solution placed over the tracheal tube will decrease the desiccation of the secretions about the tube—and will maintain a higher temperature in the trachea. The inhalation of cold air *per se* is not harmful as the ordinary cold air breathing shows; cold air may produce a different effect, however, when one part of the respiratory tract is cool and the remainder remains warm just as one usually catches no cold when entirely naked but readily takes cold if there is only a partial exposure of protected parts.

The tracheal tube and the entire wounds should be protected by gauze which should be changed frequently. The patient may sit or lie in any desired posture, though sitting is usually preferable. The entire chest and neck should at all times be well covered with oil over which a pneumonia jacket is placed. Cold drafts in the room are especially to be avoided. Nourishment should be well maintained. It is most important to keep the wound free from pus accumulation because the inhalation of wound discharges is a distinct danger. If there is no contraindication, such as an existing obstruction, it is well occasionally to remove the tube for a time, especially if the patient is fretting about the irritation. If the general precautions are scrupulously observed the great danger of tracheotomy, tracheobronchopulmonary infection may be avoided.

It has been an agreeable surprise to observe the facility with

which patients care for their tracheal tubes after they have become adjusted. It is done as a matter of routine and with the precision accompanying any other detail of the daily toilet. The author has had patients retain tracheotomy tubes for as long as twelve years before the opening was closed.

Closure of a Tracheotomy.—The ultimate closure of a tracheotomy is easily accomplished. The entire scar is bloodlessly separated from the normal tissues surrounding it just as the scar is dissected out in a case of hernia following abdominal drainage. When the dissection has reached the tracheal wall, the infiltration with novocain and adrenalin is most carefully extended throughout the basal attachment of the scar before the separation of the scar is attempted. After the excision of the scar the soft parts can very readily be brought together into their normal relation in the median line. It is unnecessary to suture the trachea directly because on the release of the scar the parts will show a surprising tendency to fall together even after many years of separation. The author has found that the wound heals by first intention and that afterward there does not remain a dimple or a depression even. If the original skin incision was tranverse there will soon be no noticeable scar to mark the place.

The cases in which the tracheal tubes were worn longest were those in which there were larynx-filling papillomata in little children. In three such cases a successful issue was finally reached—in one after twelve years, in another after nine years and in the third after fourteen. The patients were inspected at various intervals. Particularly noteworthy was a case of Dr. W. R. Lincoln—in which after fourteen years the larynx was found to be free. The tracheal tract was then closed. During this time the larynx grew normally though it had been but slightly used.

Cicatricial Stenosis of the Trachea.—Cicatricial stenosis of the trachea usually follows syphilitic ulcerations, decubitus from wearing intubation tubes, and ulceration from other causes.

This condition presents a very difficult problem. If the trachea be opened merely, the scar dissected out as neatly as possible, and the trachea then closed, recurrence is quite sure to occur. Dissection followed by the insertion of a tube gives no better results. The presence of the tube apparently increases the reaction which is marked by the formation of even more scar tissue. In the author's opinion there is but little hope in any method except in resection of the trachea. This operation offers at least one formidable difficulty —the surprisingly great elastic retraction of the trachea toward the lung, which exists even in the quiescent state, is greatly increased by

coughing. This retraction of course throws a heavy strain on the stitches and on the line of healing. This difficulty can be met by the use of mattress stitches of silver wire which include in their grasp a ring of the trachea above the stenosis and one below it. A good closure is secured by inserting three such silver wire mattress stitches, one on each lateral side of the esophagus and one in front, leaving the free end long so that it emerges freely from the wound. By twisting these wire sutures the apposition of the trachea is readily secured. This, of course, can succeed only when the trachea is quite normal. If the rings are soft or the tracheal wall edematous, the method cannot succeed.

In one of the author's cases the tracheal wall was in such poor condition that the sutures could not hold and it was necessary in the end to resort to a permanent tracheal tube. Fortunately there are not many of these cases.

Surgery of the Larynx.

Laryngectomy for Intrinsic Cancer.—The legitimacy of operation upon any part of the body, especially those parts the damage of which may cause immediate danger to life, depends upon the answers which can be given to three vital questions: Will the operation result in the cure of the disease? Can the risks be overcome? What will be the extent of permanent disability? So uncertain until very recent years have been the answers to these questions as applied to laryngectomy for cancer, that it is not strange that the operation is one of the most recent developments in surgical history, having been first performed by Billroth in 1874.

Even after surgeons had become convinced of the possibility of the cure of intrinsic laryngeal cancer by this means it was, and is still, most difficult to persuade patients to submit to it—the instinctive objection to deep throat operations being the natural outcome of the experiences of the far distant past when the throat was the point of attack in our carnivorous evolutionary ancestors, and it being still the part most liable to danger in hand-to-hand conflict.

Does laryngectomy for cancer result in a cure of the disease? Upon our answer to this depends the need for considering the other two questions. We still accept Krishaber's classification of laryngeal cancer as intrinsic and extrinsic. As the term implies, intrinsic laryngeal cancer starts within the larynx itself in the vocal cords, the ventricular bands or the parts below; while the extrinsic form starts in the epiglottis, the arytenoids or other parts outside the larynx proper. Intrinsic cancer, then, is contained within a hyaline cartilage box, and

is in large measure cut off from the possibility of lymphatic involvements; while the extrinsic form grows rapidly and can easily and early extend through the lymph channels.

Early diagnosis and removal is the keynote of safety in cancerous growths anywhere, and laryngeal cancer makes itself known almost at once, since from its very beginning the probability of its presence becomes evident in the persistent hoarse voice of the patient. We may say then, that intrinsic laryngeal cancer exists, as it were, in a safe deposit box. It early announces its presence and has but feeble power of extensive invasion or of metastasis. We conclude, therefore, that this form of cancer of the larynx is curable by excision. Extrinsic cancer, on the other hand, is rapidly fatal, and operation for its relief is at best but a desperate remedy.

What is the surgical risk? The author has performed twenty-seven laryngectomies for cancer with two operative fatalities; one death resulting from mediastinal abscess, the other from necrosis of the trachea with a consequent septic pneumonia. This makes a mortality rate of seven plus per cent, a rate which compares favorably with that of excisions for cancer of the tongue, of the stomach, and of the rectum.

What is the permanent disability of the patient? Those principally feared are impairment of speech, disfigurement, and a predisposition to pulmonary diseases and accidents. As to speech impairment, all patients acquire a buccal whisper which serves the purpose of speech remarkably well. One of the author's patients is at the head of a large industrial corporation; another is a judge; another is foreman in a public works department; another became a popular barber; still another is managing a small coal sales agency; one housewife apparently gets on well enough; and a farmer has managed his flocks and his teams in silence. The speech defect, to be sure, is great, but it can be compensated for to a remarkable degree by the development of the buccal whisper, the use of gestures and other forms of primitive language, and by the adaptation of those individuals who come into daily contact with the patient.

The disfigurement may be well covered by wearing various kinds of cravats or neckwear arranged in such a manner as to allow free breathing, and at the same time to diminish the sibilant sounds of the changing air currents.

As to the predisposition to accident and disease, to the author's knowledge there has been no instance of a foreign body in the respiratory tract of any of his laryngectomized patients, nor has there been a single case of pneumonia. Not only have his patients shown no ten-

dency to pneumonia and bronchitis, but they have been remarkably free from nasal colds.

We may conclude, then, in answer to our third question, that though the disability resulting from laryngectomy is great yet it is fairly well compensated for.

Some years ago the author made an interesting study of the laryngectomies reported in the medical press from 1874 to 1901. A summary of the statistics gives significant results. From 1874 to 1876, 12 laryngectomies for carcinoma were reported with one ultimate cure, making the percentage of ultimate cures 8.33. From 1876 to 1886, 108 laryngectomies, 21 ultimate cures, percentage of ultimate cures 19.44. From 1886 to 1896, 156 laryngectomies, 49 cures, percentage of cures 23.82. From 1896 to 1901, 30 laryngectomies, 20 cures, percentage of cures 66.67. The causes of death as reported are those with which we still are contending, but which improved technic has helped us in large measure to meet. Indeed, the figures just given show the increasing confidence of surgeons and patients in operative relief for this distressing disease, a confidence well supported by the rapidly decreasing mortality rate.

Anesthetic in Laryngectomy.—Before proceeding to the detailed technic of laryngectomy, some special statement should be made regarding the manner of administering the anesthetic. It should be borne in mind that the administration of the anesthetic should be so planned that the operator may be unhampered in his technic, that the anesthetist may give an even and safe anesthetic, and that there may be no inhalation of blood, while the choice of the anesthetic itself is a most important factor. Our general anesthetic of choice is nitrous oxid-oxygen. The patient already—it is presumed—in fear of the possible suffocating results of a laryngeal operation, takes this anesthetic without the terrifying suffocating symptoms caused by ether, and is quickly under its influence without a struggle. We have proved also by laboratory investigations that while nitrous oxid does not alter the immunity of the patient, ether on the other hand tends to impair the immunity. Since nitrous oxid-oxygen, however, should be given by the trained anesthetist only, the following technic is equally applicable to the administration of ether. In our discussion of mediastinitis we have described the preliminary tracheotomy by means of which the trachea has become firmly fixed in its position. (Fig. 105.) At the time of operation the tracheotomy tube is removed and a well-lubricated snug-fitting rubber tubing a foot or more long is slowly and carefully slipped into the trachea. The rubber tubing being slightly larger than the trachea, the latter is dilated and the rubber tube com-

pressed, so that a fluid-tight fit results. By this means, the entrance of any blood into the respiratory tract is prevented. (Fig. 106.) The long piece of rubber tubing may then be attached to the nitrous oxid-oxygen apparatus, or it may be joined to a special apparatus consisting of a funnel covered with gauze upon which ether may be dropped. By this arrangement the anesthetist is at a distance from the field of operation and is unhampered by the operator, while the operator on

Fig. 105.
Laryngectomy. Preliminary tracheotomy with iodoform gauze packing.

his side is unhampered by the anesthetist. There results an even anesthesia and the best opportunity for a well controlled operation.

To prevent nocuous impulses from the field of operation from reaching the brain, and as a protection against the excitation of special reflexes through the mechanical stimulation of the trunk or terminals of the superior laryngeal nerves, novocain is used as a local anesthetic. The manner of its administration will be given in the description of the operative technic.

Technic of Laryngectomy.—First the skin is thoroughly infiltrated

with novocain along the median line from a point above the hyoid bone to the tracheotomy opening. The tissues are divided down to the box of the larynx, the divisions of the platysma and of the other soft parts being preceded also by novocain infiltration. The dissection is then

Fig. 106.

Laryngectomy. Five days after preliminary tracheotomy. Arrangement of tube for anesthesia.

carried down along the lateral aspects of the larynx until the larynx is completely freed. If there is lack of free working space at the upper end a lateral incision is made parallel with the hyoid. The thyrohyoid muscles above and the sternothyroid muscles below are severed. So far as its muscular attachments are concerned, the larynx is now completely mobilized. If the laryngoscopic examination has fixed accu-

rately the limits of the neoplasm, the level of the division of the larynx may be predetermined, and the next step will be the division of the trachea or the cricoid at a level free from disease. Before this last division is made, however, novocain is infiltrated into the mucosa throughout the entire length of the proposed division. By this means the terminals of the superior laryngeal nerves are completely blocked and the mucosa may be divided and the larynx opened without causing a change in the respiration or the circulation. If the patient is old and the cartilage is ossified it is necessary to exert the greatest pre-

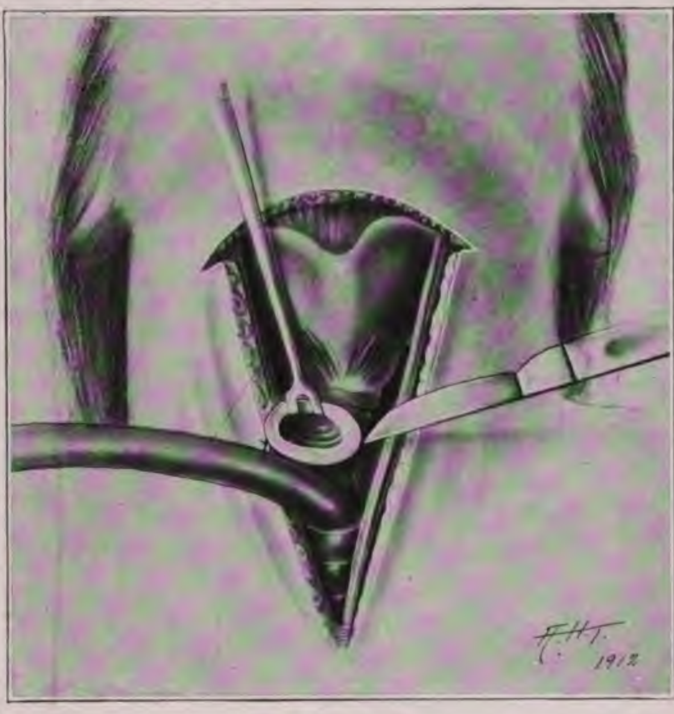


Fig. 107.
Laryngectomy. Separation of the larynx from the esophagus.

caution in dividing the larynx in order that the esophagus may not be injured. The divided end of the larynx is next raised up and the attachment between the larynx and the esophagus is divided with knife or scissors. (Fig. 107.) In a short, thick neck the wings of the larynx which extend down laterally to protect each side of the esophagus, are divided with scissors. The dissection is then carried upward until the upper end of the larynx is reached, where its posterior wall becomes fused with the anterior wall of the pharynx. The upper end of the larynx is then cut free, the larger arteries being severed at the very last. Hemostasis must be most thoroughly ob-

served throughout the operation. If the cancer is intrinsic the lymphatic glands which drain the diseased zone should be carefully removed with the larynx itself.

Two important questions now arise regarding the manner of dealing with the wound: (1) What shall be done with the end of the trachea? and (2) Shall the entire wound of the neck be closed? As to the trachea, there are two alternatives: It may be freed sufficiently to bring it forward and stitch it to the skin, or it may be left where it lies, excepting at its very upper end, which may be bent forward

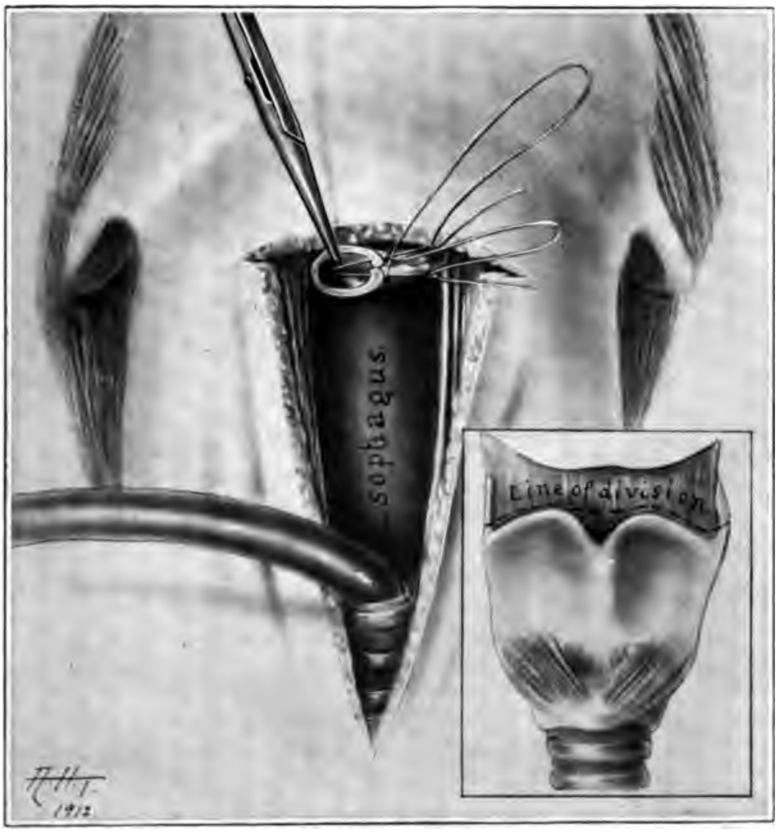


Fig. 108.
Laryngectomy. Closure of pharyngeal opening.

and sewed to flaps of skin brought down from each side. The advantage of the first method is that by this means the trachea is protected from the inhalation of wound secretion. The disadvantage is the very definite possibility that the loss of blood supply may result in gangrene of the trachea. This did occur in one of the author's cases. The objection to leaving the trachea in its natural bed and transplant-

ing to it the skin flaps is the fact that wound secretion will almost certainly enter it. By giving the wound adequate care, however, this danger may be avoided.

As to the care of the rest of the wound, the author's best procedure has been to suture the opening in the pharynx and (Fig. 108), if possible, to reenforce this suture by drawing other soft parts together over it. The rest of the field is left open, being packed lightly with iodoform gauze. (Fig. 109.) With such a wide open wound the secretions may be easily controlled and prevented from entering the trachea. The patient should be sustained by the fullest diet he can

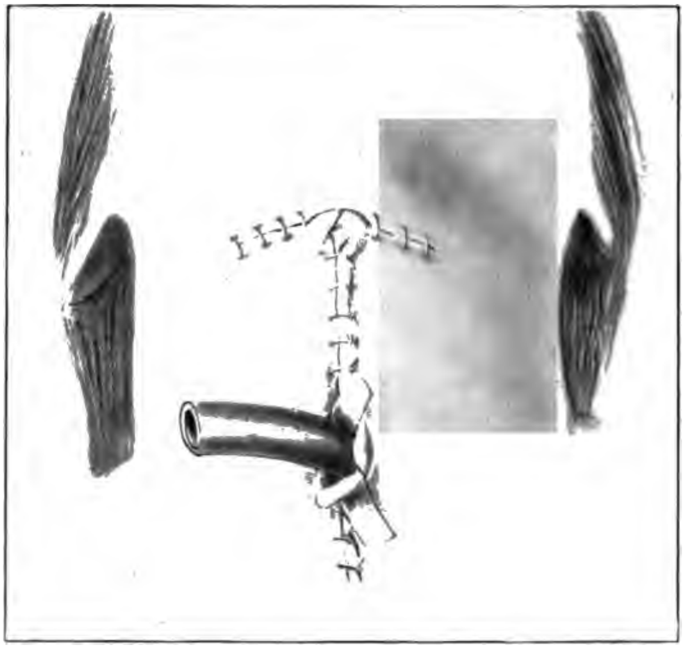


Fig. 109.
Laryngectomy. Closure of wound with iodoform gauze packing.

be made to take, and by most careful nursing. The sutures in the pharynx may not hold, but the formidable-looking wound will close very readily by granulation and contraction.

Laryngectomy is followed usually by a brisk local reaction; but since the mediastinum has been protected by the previous gauze packing, and the bronchopulmonary tract has been given a special defense by the preliminary tracheotomy, the patient is well equipped to meet the new condition.

In the author's twenty-seven laryngectomies there were two deaths, and these two were apparently the most promising cases of all. The prognosis in these cases seemed so favorable that the author

ventured to discard the full preliminary preparations. In one case no preliminary protective operation of any kind was made and the patient died at the end of five weeks with mediastinal abscess. In the other case a preliminary gauze packing was placed in the neck around the trachea, but no preliminary tracheotomy was performed. In this case the isolated upper end of the trachea was brought forward to the skin and anchored. The entire isolated portion necrosed, as did also a portion of the trachea beyond the isolated part. As a result pus was inhaled into the respiratory tract below the level of the sternum. An autopsy showed no pneumonia and no mediastinitis, but a septic tracheitis and bronchitis. Death was the result of local absorption, and of absorption from the trachea and from the bronchial mucosa. This case demonstrated most conclusively the efficiency of the granulation barrier which is created by a preliminary iodoform packing. Had a preliminary tracheotomy been made, or had the trachea been allowed to remain in its bed, the patient would surely have recovered.

In sixteen of these twenty-seven laryngectomies for cancer the laryngeal box was so choked with the growth that tracheotomy was required to prevent suffocation. Most of the author's patients gave a long history of hoarseness followed by gradual, though intermittent obstruction to respiration. In two cases, there was associated lues. One of these last two cases illustrated well the clinical difficulty of diagnosis. The lesion was first diagnosed correctly as luetic, and under a course of treatment the greater part of the growth disappeared. The residual growth, however, showed a progressive tendency, and was later diagnosed as cancer. Laryngectomy was performed and the patient is now alive and well, more than three years since his operation. The special lesson from this case is that cancer of the larynx, like cancer of the tongue, may follow local luetic lesions. There is danger, therefore, that the hope of a luetic cure may defer too long the laryngectomy which is the only chance for the cure of the cancer.

Extrinsic Cancer of the Larynx.—As already stated extrinsic cancer of the larynx presents a different and a more desperate problem than does intrinsic cancer. Extrinsic cancer is more difficult to attack on account of its position; it is disseminated earlier and more widely on account of the greater muscular activity of the parts involved. Extrinsic cancer of the larynx is however more accessible than cancer of the tonsil or cancer of the pharynx. The same considerations apply to cancer of the base of the tongue.

In attacking cancer here a preliminary tracheotomy is essential, wide neck incisions are made, the cancer is exposed most cautiously and is thoroughly thermocauterized. In the further dissection great

care must be exercised not to disturb the eschar. After complete and wide excision of the cancer the wound should be left wide open for the free use of the X-ray.

In one instance the author excised the base of the tongue, the pillars of the pharynx, the pharynx itself, the entire larynx, the hyoid, —in short all of the tissues lying between the juncture of the posterior and the middle third of the tongue, the upper ring of the trachea and the upper end of the esophagus, leaving but a slight covering of the vertebræ. This enormous wound looked hopeless for a long time—during which the X-ray was used freely—but finally closed completely.

About four years later metastasis developed in one of the submaxillary lymphatic glands. When the author saw it, this gland was quite large, was inflamed, hugged the jaw closely and involved the swollen reddened skin covering it. Again a wide excision was made, so extensive that the wound could not have been closed had the author so desired. The X-ray was used freely during the process of healing. The lower jaw was so closely hugged by the cancer that about one-third of the jaw was sawed off longitudinally—the sawed fragment of bone coming off with the rest of the cancer. In due time the wound was skin grafted and closed. It has been over five years since this last operation and nine years since the first. The patient is now at work. He speaks with a sort of a buccal whisper,—is able to swallow, to drink and to smoke with ease and comfort.

This case taught the author that no one can tell when a case is hopeless—for surely this patient seemed to be in a hopeless condition. The repair of the mutilations produced by this operation in which so many important structures were removed and the consequent recovery have been a source of encouragement and inspiration ever since.

In another case of extrinsic cancer the operation in a local field was not so extensive but the lymphatic involvement was much greater. In this case the growth had so filled the larynx that the obstruction had caused asphyxia, as a result of which the patient had fallen upon the street. An emergency tracheotomy was performed, at which time one of the lymphatic glands was removed for diagnosis. At the later operation the excision was carried laterally so as to include the lymphatic gland-bearing tissue on both sides, all of which was removed *en bloc* with the larynx and the base of the tongue. The patient is well and hale seventeen years after the operation.

Stenosis of the Larynx.—Stenosis of the larynx may be due to intubations—now infrequently done—or to ulcerations which are usually syphilitic. Like stenosis of the trachea—already described—stenosis of the larynx is an exceedingly formidable condition.

The author has attempted to open the larynx by splitting it vertically, dissecting out the scar and then resuturing the incision, but the stenosis recurred so promptly that the patient was denied the comfort of a goodly respite even.

In another instance the author did a hemilaryngectomy in the hope that the larynx might adapt itself as it may do in hemilaryngectomy for cancer—but this did not afford a permanent air space.

In another case the larynx was opened wide, the scar was completely dissected out and an attempt was made to cover the raw area immediately with large and accurately placed skin grafts. The respiratory tract and the grafts as well were protected by a tracheotomy. Despite the utmost care the grafts did not grow. For a time they did well, but the patient was a child only four years old and hard to control. The author gained the impression, however, that were it an adult case and the skin grafts autodermic they might have held. Even then, however, one could not be certain that the scar might not again contract. In a child with stenosis of the cricoid referred to the author by Dr. W. B. Chamberlain, an attempt was made to remedy the stricture by resecting the lower end of the cricoid and suturing the trachea and the divided cricoid together by means of silver wire. The resection of the strictured cricoid was easily accomplished but as the trachea was so much smaller it was difficult to bring it into precise tubular apposition. Although a union was secured the stenosis was not relieved and the author was obliged to resort to a permanent tracheal tube. With our present means the author is unable to see much hope in operations for strictures of the larynx. In one case massive scar tissue firmly fixed to the box of the larynx. In one case the use of thiosinamin was added to the operative procedure, but apparently its influence was nil.

Surgery of the Pharynx and Esophagus.

Cancer of the Pharynx and Esophagus.—Hitherto cancer of the esophagus and of the pharynx has not been attacked as successfully as cancer in many other parts of the body. When dealing surgically with cancer in these regions it is important to bear in mind that if cancer cells become lodged in the fresh wound they are not only likely to grow, but to grow with even greater vigor than in the original lesion. There is not an abundance of experimental evidence to support this statement but ample clinical proof is not lacking. The experimental evidence that is especially pertinent is the following: If a piece of cancer tissue from a dog is rubbed on an abraded surface of the skin of another dog a cancer is likely to develop from the cells which became detached and lodged on the denuded surface.

In operations for cancer anywhere if the field is not protected the entire raw surface area will be sown with cancer cells and a rich growth of cancer will spring up over the entire wound surface, will grow furiously and usually will cause the death of the patient in less time than would the original growth had it been left unmolested. This is perhaps the most important point to be considered in the treatment of cancer of the pharynx, the tonsil, the pillars or the rima glottidis. The operation is technically beset with difficulties but no instrument, no finger, no sponge, that has touched the cancer surface, should be used again, nor should they touch anything else that may be used in the operation. The operation should not be undertaken if its result is to be no more than the implantation of a new cancer that may extend even farther than the original growth. The only means by which the reimplantation of cancer cells may be prevented is by the immediate and complete destruction of the original growth by thermo-cauterization. Care must then be taken to prevent the dislodgment of the eschar—and even after these precautions have been taken it is best to follow the operation by the use of the X-ray if the field is accessible. It is wise also to make a very wide excision of the growth, and to remove all the lymphatic nodes which drain the involved area. In serious risks it is best to perform the operation in two stages, first excising the local field, and then after ten days or more removing the lymphatic bearing tissue of the neck by a block excision. If the growth is located in the tonsil or the pillars it is possible to give the anesthetic and to prevent the inhalation of blood either by passing tubes through the pharynx and packing them with gauze, or by the intratracheal insufflation method of Meltzer and Auer. If the cancer is still lower down, it is best to make a preliminary tracheotomy and introduce as large a rubber tube as the trachea will hold, thus preventing the inhalation of blood. In operations on the tonsil the application of a Crile clamp on the external carotid artery will minimize the hemorrhage.

Excision of the Tonsil for Cancer.—Bearing in mind the general precautions stated above, the excision of the tonsils for cancer is performed in the following manner:

1. A tube for the administration of the anesthetic is passed through the pharynx and held by gauze packing.

2. All of the visible growth is completely destroyed by thermo-cauterization.

3. The lymphatic glands which drain the tonsil are excised *en bloc* through a wide neck incision.

4. The external carotid is closed by means of the Crile clamp.

5. If more room is needed the ramus of the jaw is divided.

6. With the fingers of one hand inside the throat a wide dissection is made of the base of the growth, extreme care being taken to leave undisturbed the eschar surface. Internal as well as external dissection should be used if necessary.

7. The vessels are closed carefully. A curved needle and catgut being used if necessary to control oozing in the mouth.

8. The clamp is removed from the external carotid.

9. A Lane plate is applied to the divided ramus. The plate may cause suppuration, but it will hold the bone in place until union has been secured.

10. The wound is immediately exposed to X-rays if the patient's condition warrants it.

11. The wound is packed with iodoform gauze—the external wound being partially closed.

Cancer of the Pillars—In operations below the tonsil the best procedure is to perform a tracheotomy and then to open the pharynx freely by means of an ample incision just above the hyoid. The same procedures as those described in the operation for cancer of the tonsil are applicable here except that the wound in the neck, by means of which the exposure is made, is closed at once, and it is not necessary to apply temporary clamps upon the carotid. It is well to allow the tracheotomy tube to remain until the pharyngeal wound is well healed.

Stenosis of the Pharynx.—The discouraging results of operative procedures for the relief of stenosis of the pharynx are well illustrated by the following history of one of the author's cases. This patient has already undergone twenty-four operations of various kinds including all the intrapharyngeal methods. The author resolved to make a wide excision of every vestige of the stricture. A preliminary tracheotomy was made, ten days after which the principal operation was performed. An incision was made around the anterior half of the neck through the skin, platysma and fascia. The pharynx was then opened. With one hand inside the pharynx the dissection above and below the stricture could be accurately guided so easily that the author was able to make an annular resection including the entire area of the scar. By means of a long needle with an eye near the point mattress stitches were inserted into the opposing pharyngeal walls, thus bringing together this enormous opening in the throat. The wound healed splendidly, but after some months the stricture recurred.

The author then planned another type of operation. A long perineal needle with an eye near the point, threaded with heavy silver wire, was passed through the skin of the side of the neck and through

all the soft parts down to the base of the stricture. The base of the stricture was then pierced, the needle passing into the mouth. The silver wire was then detached from the eye and the needle was withdrawn until the point was once more external to the base of the stricture, and was then passed through the small opening in the center of the pharynx. The free end of the silver was again threaded into the eye of the needle and the needle was withdrawn. In this manner one side of the scar was grasped by the loop of heavy silver wire. Another wire was similarly inserted into the opposite side and both wires were tightly twisted. The purpose of this procedure was to form a mucous-membrane-covered fistula analogous to the skin fistula one makes when operating for web finger. This was faithfully tried but unfortunately the wake of the wires filled as fast as they cut their way out. The author then abandoned further efforts and made an esophagostomy, which appeared to be the only possible means of relief.

Esophagostomy.—Like tracheotomy and enterostomy, esophagostomy may be permanent, or it may be used for temporary purposes only. The author has many times made use of esophagostomy for a temporary purpose, closing it after it has served its purpose. The most striking case of this nature was the case of extrinsic laryngeal cancer already described in which the larynx, the hyoid, a large portion of the pharynx, the tonsils, the base of the tongue and all of the intervening tissue were excised. At the end of the operation no pharyngeal mucosa was left. The esophagus was stitched up into the skin at the side of the neck and was securely fastened with silk sutures. The trachea was stitched to the opposite side. After a time new mucous membrane spread over the pharynx. The author then in several stages freed the esophagus from its attachment to the skin at the side of the neck and brought it to the median line. In two more seances he sutured the large hiatus in the anterior pharynx. After a good union was secured the esophagostomy opening was finally closed. The patient made an excellent recovery.

In performing an esophagostomy the important point is to make the incision so ample that all the field may be seen clearly. (Fig. 110.) The dissection should be so controlled that the recurrent laryngeal nerve, the big blood vessels, the vagus and the other important structures may all be so clearly seen that they cannot be mistaken nor injured. (Fig. 111.) If each step in the operation—however minute—is controlled not the slightest mishap need occur. After the esophagus has been reached, however, it is important to avoid extending the dissection in the neck the least bit more than is required; for, in the

first place, a wide dissection is not needed; and, in the second place, the deep planes of tissue in the neck have but little power of resisting infection.

If no emergency exists, it is even safer to bring the esophagus well up into the wound; to pass a small strip of iodoform gauze around

Fig. 110.
Esophagostomy. Ample incision of skin along the anterior border of sternomastoid muscle.

it; and to pack the wound gently for several days before the esophagus is opened. This point is not of sufficient importance, however, to justify any loss of time. The fixation of the esophagus to the skin is most safely made by means of silk interrupted sutures. (Fig. 112.)

The author has been happily surprised to observe the ease with which patients swallow even when the esophagus is brought to the edge of the skin wound.

Cancer of the Esophagus.—Cancer of the esophagus is rarely cured for usually the condition is not recognized until symptoms of obstruction appear, by which time the disease has almost certainly spread into inaccessible territory.

The technic of resection of the esophagus for cancer is essentially the same as that already described for esophagostomy. The incision should be ample enough to expose the cancer for a considerable distance above and below the limits of the cancerous tissue. It is rarely possible to unite the ends of the divided esophagus.

Diverticula of the Esophagus.—Operations for diverticula of the

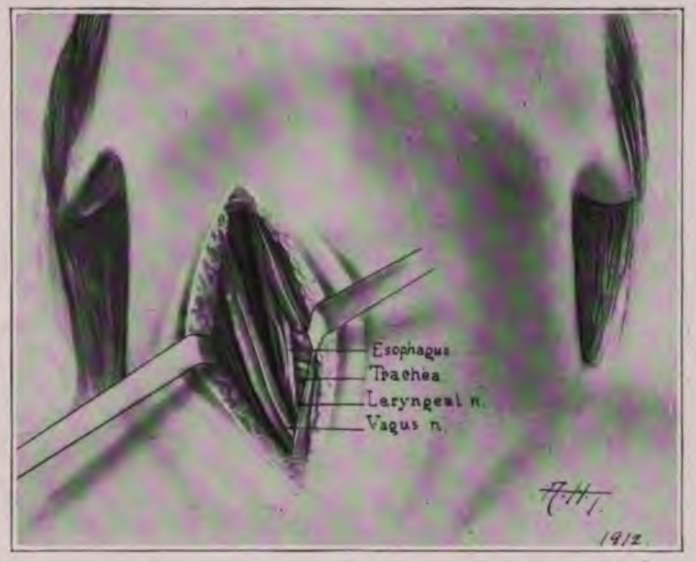


Fig. 111.
Esophagostomy. Exposure of esophagus.

esophagus present a sharp contrast to those for pharyngeal stricture, for the former are usually successful. The author has operated on five cases and found them readily curable.

Before operation X-ray bismuth pictures should be made to determine the exact location, the extent and the nature of the sac which is most commonly situated at the upper lateral aspect of the esophagus, often extending downward below the clavicle even.

The operation is performed in the following manner:

1. A long vertical incision is made over the middle of the sac.

2. By sharp knife dissection the sac is exposed, the field being kept bloodless and translucent by picking up and clamping each vessel either before or at the moment of its division.

3. The entire pouch or sac is isolated up to its esophageal or pharyngeal point of origin.

4. The sac is cut off exactly as one cuts off a hernial sac. The opening of the diverticulum is closed by a silk suture preferably with a cobbler stitch. The first row of stitches is reenforced by a second row, and a small drain is inserted at the lower end of the wound after closing the overlying tissues.

If the diverticulum be high up on the esophagus, especially if it involve the pharynx, the patient should not be allowed to swallow until the line of union is well established. As the victims of esophageal diverticula have usually had much experience with throat and

Fig. 112.
Esophagostomy. Esophagus stitched to skin.

esophageal instrumentation, the insertion of a small flexible tube through which nourishment may be given will be no hardship.

One of the author's patients had had another diverticulum removed twelve years previously. In this case the pharyngeal wall was strikingly thin, and in addition to two diverticula the pharynx was greatly dilated on the same side. The site of the first operation was clearly visible, the scar being sound. Both diverticula were removed and in addition a large elliptical portion of the dilated pharynx was excised. The result has been excellent.

Diverticula with narrow necks are of course the easiest to remove.

CHAPTER V.

LARYNGOSCOPY, TRACHEOSCOPY, BRONCHOSCOPY, ESOPHAGOSCOPY, AND GASTROSCOPY.*

By Harris P. Mosher, M. D.

THE DIRECT EXAMINATION OF THE LARYNX.

Historical.—Kirstein in 1894 introduced the direct method of examining the larynx. The instrument with which he accomplished the exposure of the larynx was an elongated tongue depressor with hoods of various sizes. Killian took up the procedure, and changed the flat speculum of Kirstein into one of tubular form, systematized the steps of the examination and won from the medical profession the recognition of its great value. The foresight and enthusiasm of Killian have been supplemented by the great inventive ability of Brünings. The result of the labors of these men has been that a number of instruments are available today for the direct examination of the larynx.

The advantages of the direct examination of the larynx are self-evident. It is the natural method. The physician works upon the larynx in the same fashion that a surgeon works upon any other part of the body. Manipulations in the larynx carried out under the guidance of a mirror, are executed round a right angle corner with the anterior and posterior positions of the various parts of the larynx reversed. The indirect method of examining and operating upon the larynx must be credited with very great accomplishments, and it will always be employed, but the special workers of the coming generation will turn instinctively to direct manipulations upon the larynx rather than to the older procedure.

Contraindications.—Absolute contraindications to the employment of direct inspection of the larynx are seldom found. Chief among these is a high grade of dyspnea. The direct examination should not be attempted in severe cases of uncompensated heart lesions, or in a

*This article is based upon the writings of Brünings, Kahler and Jackson. The author's own experience furnishes a certain small part. Epitomes of new work, and such in great measure is this article, must go to the original sources for the facts. This the author has done. He wishes here to make full and grateful acknowledgment of his indebtedness.

case of advanced aneurism. Intractable gagging in spite of thorough cocainization is not so much a contraindication, although the result is the same, as it is an insurmountable obstacle. Where the direct examination proves to be impossible, it is generally due to uncontrollable reflexes. However, unless there is some disease of the cervical vertebræ or some unusual malposition or deformity of the larynx the direct examination is almost always possible under general anesthesia. Where the patient is suffering from marked dyspnea the performance of tracheotomy usually makes the direct examination possible.

Uncontrollable gagging, the chief difficulty in carrying out direct examination, interferes fully as much in the indirect method as it does in the direct. In either case it must be successfully combatted before the examination can proceed.

The Choice of the Aesthetic.—In examining the larynx directly the operator has the choice of local or general anesthesia. Some form of anesthesia is necessary on account of the gagging and coughing far more than on account of the pain, since the manipulations employed in the direct examination of the larynx and trachea give rise to but little pain. It is essential, therefore, to do away with the sensitiveness only of the mucous membrane. This can be brought about either by the use of cocain locally or by the production of general anesthesia in addition to local anesthesia, because even with the general anesthesia, the use of cocain is necessary. The operator ought not be a partisan in this matter. He should employ either form of anesthesia at will. Infants and children are best examined under general anesthesia. In many adults a satisfactory examination is possible only under ether. Certain systemic diseases like multiple sclerosis, bulbar paralysis, tabes, and hysteria, increase the sensitiveness of the mucous membranes. In old subjects the mucous membrane of the larynx and trachea is often very tolerant. In robust males with chronic catarrh, twice or three times the amount of cocain as is required for women is often needed to produce anesthesia.

Cocainization.—Brünings with his customary thoroughness has studied the methods of cocainization exhaustively. He has demonstrated that cocain applied by a brush or swab is three times as effective as it is when introduced by a spray. If adrenaline is added to the cocain solution the anesthesia is noticeably prolonged. Brünings uses a syringe which he converts into a swab syringe by winding cotton on the tip of the canula. The barrel of the syringe is graduated so that the operator can control the dosage of cocain. This author finds that on the average five drops of a twenty per cent solution is sufficient to produce anesthesia in an adult. In children the strength of the solu-

tion is reduced to ten per cent, because they do not tolerate the drug as well as adults.

With a swab or the swab syringe, a drop of a twenty per cent solution of cocain is applied to the base of the tongue, and another to the posterior pharyngeal wall. After an interval of three or four minutes the cocain is applied to the tip of the epiglottis. Finally a drop or two is placed in the larynx. This calls for accurate dosage. The writer of this article has not had any experience with the brush or swab syringe, but has used the simple swab and with it a ten per cent solution of cocain for the first of the anesthesia, and a twenty per cent solution in the larynx. The weaker solution allows the cocain to be employed more freely. Until the beginner perfects his technic he will do well to use the weaker solution for the most part. If cocain is mixed with adrenalin chloride much stronger solutions can be used in the larynx. Some operators employ as high as fifty per cent.

The Difficulties of the Examination.—The greatest difficulty in the way of a successful examination is incomplete anesthesia. Time is lost and the examination is rendered incomplete or made impossible unless the anesthesia is profound. From its nature the procedure of direct examination is disconcerting if not alarming to an inexperienced patient. Therefore, the patient should be calmed by the assurance, repeated if necessary, that he will not strangle. He is encouraged to hold the head as loosely as he can and to breathe quietly and regularly. From time to time the examination is interrupted in order that the patient may spit out the accumulated saliva. He is cautioned to do this quietly and not to hawk. During the examination the patient is liable not only to bend the head too far back but to allow the whole body from the knees up to swing backward. The assistant should see to it that the patient keeps straight and erect. These are the principal and natural faults into which the patient falls. The faults of technic to which the examiner is liable are also natural ones. The first, incomplete cocainization, is due to haste. For the patient's sake he wishes to get the examination over quickly. The second mistake on the part of the physician is to insert the speculum too deeply at first and in consequence to miss and to pass the epiglottis and to strike the point of the instrument against the posterior pharyngeal wall. This produces uncontrollable gagging and often, for the day at least, makes further manipulation impossible. In pressing the epiglottis and the base of the tongue forward the speculum should be held firmly and the procedure executed in a deliberate and unhesitating fashion. Otherwise the tongue is tickled and rebels. Under firm pressure it yields and submits. When the tip of the speculum has en-

tered the larynx there is danger of the shaft striking against the teeth or the unprotected gums, thus causing pain. The examiner's finger should be so placed as to prevent this. The success of the examination depends most of all upon the character of the patient's neck. If he has a thin neck, and if he is fortunate enough to have no teeth the prospects of a successful examination are good. If, on the contrary, the patient has a short, thick neck, and a protruding upper jaw and retains all his teeth, the outlook for the examination is not so hopeful.

The amount of force required to bring the larynx into view varies with the individual neck. Brünings has made the observation that a force of 10 kg. is bearable, 15 kg. painful, and 20 kg. unbearable. He has found also that the ease of seeing the anterior commissure varies greatly; in fact it may be thirty times as difficult in one patient as in another. The harder it is to obtain a view of the anterior commissure the smaller must be the diameter of the speculum. With a speculum of 9 mm. diameter a pressure of 9 kg. will expose the anterior commissure. With a speculum of 14 mm. diameter the same amount of force will expose only the posterior part of the larynx.

The Method of Making the Direct Examination.

The patient should be examined if possible when the stomach is empty. If the physician feels that his patient will be unruly a dose of bromid or morphin some little time before is of benefit. The patient is seated upon a low stool (30 cm. in height), and the assistant stands behind and supports the head. The patient's head is bent slightly backward.

The patient protrudes his tongue and holds it with his left hand. The examiner guards the upper teeth of the patient with the forefinger of his left hand at the same time pushing the upper lip out of the way. The thumb of the left hand is held against the left forefinger and the angle between the two fingers is made to serve as a guide for the shaft of the speculum. Two forms of specula are used for direct examination, the tubular speculum of Jackson (Figs. 113 and 114) and the speculum of Brünings. Suppose that the instrument of Jackson is the one which the examiner is using. It is manipulated as follows: The blade of the speculum is carried into the mouth along the central line of the tongue until the tip of the epiglottis appears. As soon as this is recognized the end of the speculum is carried over it. This is the first stage of the examination, if for purposes of clearness the examination is described in stages. It is vital for the success of the examination not to have this first manipulation miscarry. When the epiglottis has been passed by the tip of the speculum, the handle of

the instrument is gently raised and at the same time the patient's head is allowed to swing backward slightly and by degrees. As the head of the patient goes back the end of the speculum is pushed downward along the posterior surface of the epiglottis into the vestibule of the larynx. From the moment that the tip of the epiglottis has been passed until a satisfactory view of the larynx is obtained, firm pressure is kept upon the base of the tongue by lifting up the handle of the speculum and thus forcing its shaft and tip forward. The discovery and the passing of the tip of the epiglottis constitute the first stage of the examination, the sinking of the speculum into the vestibule of the larynx the second, and the pushing of the epiglottis and the base of the tongue forward,

Fig. 113.
Jackson's tubular speculum. The instrument is made in two sizes, for children and adults. Johnson has modified this speculum by making the horizontal part of the handle detachable.

the third stage. If at any time the examiner loses his way, that is, misses the epiglottis, or strikes the posterior pharyngeal wall or finds himself in the pyriform sinus, the speculum should be withdrawn and the examination started again from the beginning. It is a help, after the tip of the epiglottis has been passed and the speculum is about to enter the vestibule of the larynx, to ask the patient to speak, in order that the movement of the arytenoid cartilages may give the proper direction for the deeper introduction. A successful examination should be a matter of only a few minutes.

Passing the Speculum from the Corner of the Mouth.—If there happens to be a sufficient gap between the teeth on either side of the upper jaw advantage may be taken of this space to pass the speculum

at this place. If no gap exists and the incisor teeth are prominent, the speculum may be passed between the bicuspid teeth or from the corner of the mouth. The distances are shorter and the muscles more relaxed. For this purpose the head of the patient is rotated a little and bent slightly to the opposite side. Carried out with a small Jackson speculum this method of making the direct examination is very successful in children and infants. This procedure has been especially developed by Johnston.

The Direct Examination With Counter Pressure.—In the direct examination it is the forward pressure of the speculum which enables the operator to see the larynx, but this at the same time limits his view because the larynx as a whole is dislocated considerably forward. In

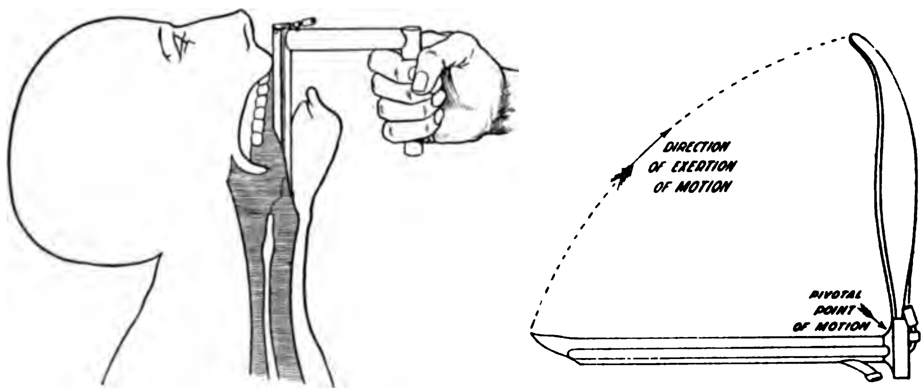


Fig. 114.

Diagrammatic representation of direct laryngoscopy and schema, showing direction of force applied in using the tubular speculum. (After Jackson.)

order to counteract this the operator almost instinctively puts his finger on the larynx from the outside and pushes it backward. Brünings has given this common manipulation a special name, direct examination with counter-pressure, and has devised an instrument to do the work of the physician's hand, and so free it for other uses. With this instrument the inventor states that the anterior commissure can be seen in all cases.

The Direct Examination Under Ether.—The patient is prepared for general anesthesia in the usual way. Before he comes to the examining table he is given, if an adult, a sixth of a grain of morphin and one one-hundred and fiftieth of a grain of atropin. The patient is placed on his back on a table high enough to bring the head to the same level as the face of the examiner if he prefers to work sitting. If he prefers to work standing the table is put upon a platform. The

author has found it less tiring and less awkward to make the examination standing. (Figs. 115 and 116.) The head and shoulders of the patient are brought over the end of the table while an assistant supports the head with his left hand upon his left knee. The knee of the assistant is supported at the proper height by an adjustable foot rest. When the ether has been well started the physician cocainizes the deep pharynx of the patient and the region of the pyriform sinuses with a swab

Fig. 115.
Position of second assistant and patient for endoscopy per os. Gowns, caps and covers are omitted to show the position better. (After Jackson.)

saturated with a ten per cent cocain solution. Often it is a help to have a suture through the tongue. The introduction of the speculum is the same as under local anesthesia except, of course, that in the majority of cases it is easier. The ether examination is resorted to when the patient is intractable under local anesthesia. It is used in the case of children, or when, besides making an examination, operations of considerable extent are to be carried out. The assistant should so hold the head of the patient that he can at any moment

transfer it to the hand of the physician. Often the physician can obtain a better view by manipulating the position of the head for himself. In a hard examination the head passes many times from the hand of the assistant to the hand of the examiner. The assistant's free hand is ready at any moment to push the larynx back and to manipulate the

Fig. 116.

Bronchoscopy room at Massachusetts General Hospital. The elevated platform is shown, with the operating table and the assistant who holds the patient's head. The rheostat and dry cell battery are seen on the wall at the left. Behind the assistant is a Coakley lamp. On the left also, but not shown in the photograph, are the electric suction pump and the ground glass box for holding X-ray plates.

anterior commissure into view, or to close the cords in order to show the presence of a new growth.

In examining children under ether it is not always necessary to bring the head over the end of the table. If the occiput is allowed to rest on the table and the chin is brought up, in very many instances a perfect view can be obtained. It is well to try this position first. Often

this position is successful also with adults. If it does not succeed the head may be turned to the side and the speculum carried down between the bicuspid teeth or from the corner of the mouth. This manipulation is especially useful for introducing the bronchoscope between the cords because it is easier to get in line with the trachea in this way than it is from the middle line.

For operating purposes Brünings employs an open speculum. Some years ago the author devised practically the same kind of a speculum, and used it for some time but soon replaced it by an open adjustable speculum of the pattern shown in Figs. 117 and 118. An open speculum increases the operating field. Such a speculum

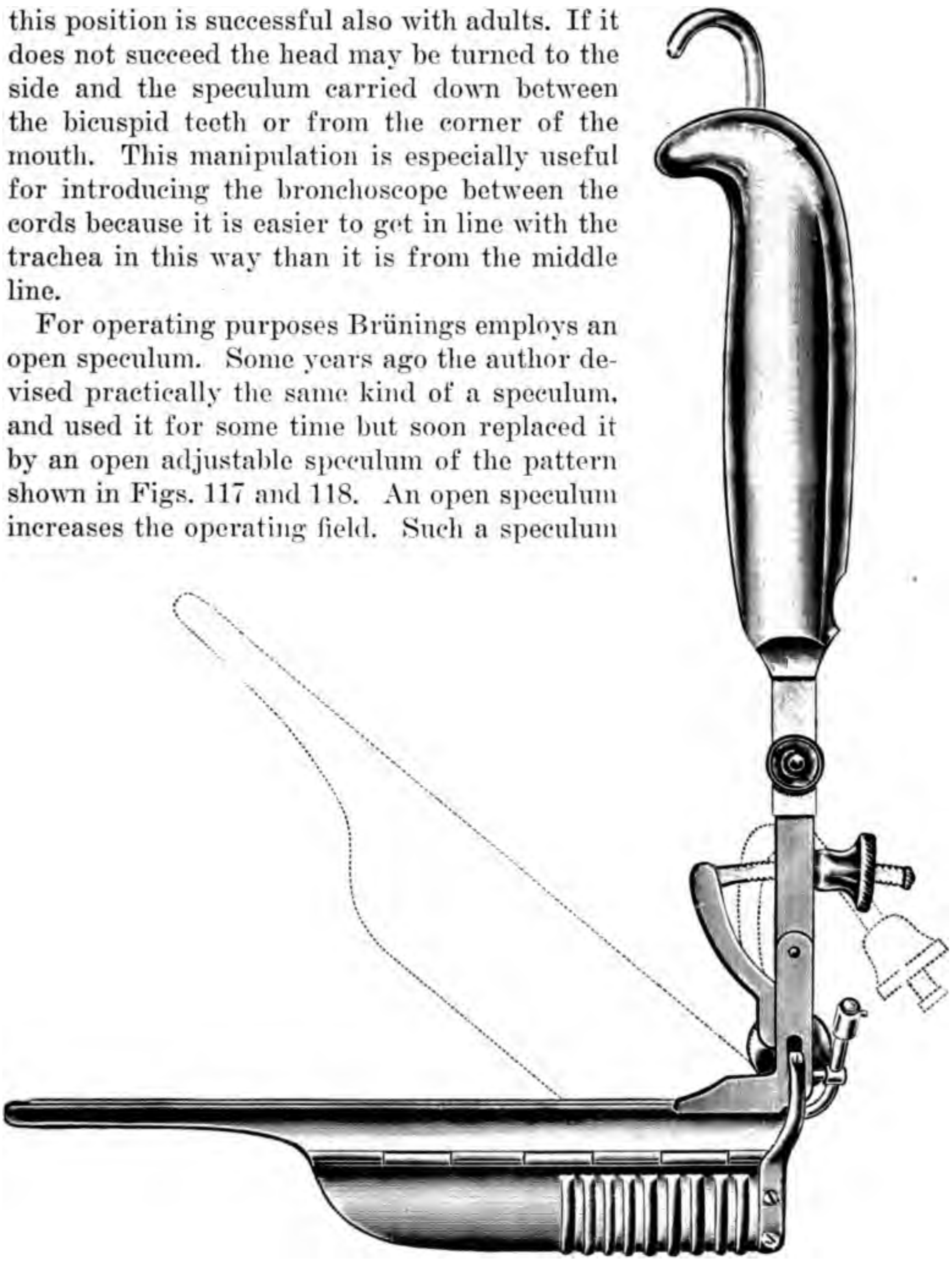


Fig. 117.

Mosher's adjustable speculum for direct and suspension laryngoscopy. (Side view.)

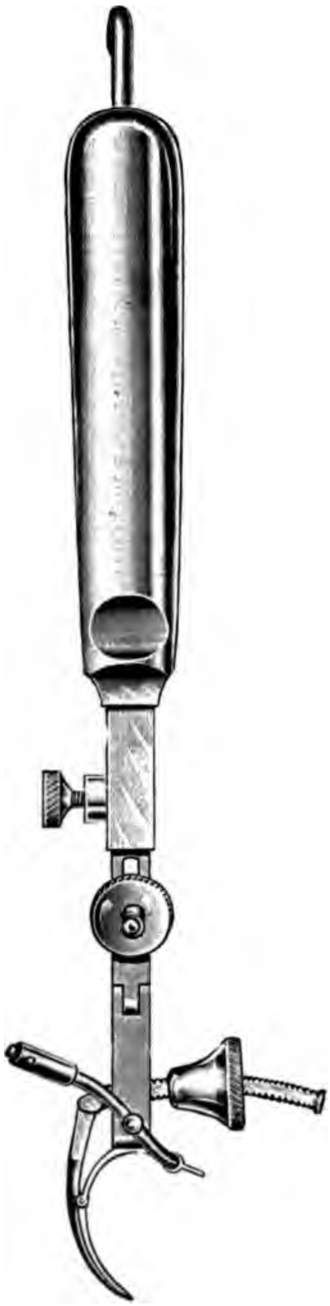


Fig. 118.

Mosher's adjustable speculum, showing the mechanism by which the speculum can be adjusted to any width.

is the only pattern through which direct intubation with the larger tubes can be performed. The eye strain in using the open speculum is lessened. All the landmarks of the pharynx and larynx are visible at once and in their natural perspective. The writer is very partial to the open speculum when it can be employed. In children it is especially successful. In appropriate necks of adults it is also successful. The author always tries this form of speculum first because when it succeeds no other speculum gives as good a view. The open speculum may be used with or without general anesthesia. However, with infants and young children for obtaining a diagnostic view of the larynx, for intubation, for extubation, or for removing coins from the upper part of the esophagus it can be employed without ether.

The Instruments for Direct Examination and Direct Operating.—The examining instruments are the tubular speculum of Jackson, the speculum of Brünings lighted by the electroscope, and fitted with the attachment for counter-pressure, and some form of open speculum. The light for the open speculum may be obtained by Jackson's method, or by reflection from a head mirror. The instruments used through the various specula in direct operating upon the larynx are made with the shaft of the proper length and at an appropriate angle with the handle. The first instrument is the laryngeal knife. The other instruments come under the head of punches or grasping forceps. (Fig. 119.) The shaft of the instruments should be as thin as possible and retain its rigidity. The instruments of Brünings are most excellent. In using instruments which work with a scissor motion it is hard to judge when they are placed at the proper depth. They either fall short or overreach the growth to be seized. It is

easier to adjust accurately an instrument the blades of which are placed at right angles to the end of the shaft and which close upon each other from above downward. The lower blade can be carried below the growth and then brought upward until the movement of the growth shows that the blade is touching it from below. If the blades are then shut the bite is usually successful.

In hard examinations where neither the position of the head nor counter-pressure will cause the speculum to bring about a sufficient view of the larynx, and the writer must confess that he has had such cases, a small, short bronchoscope introduced from the angle of the mouth will at times bring into view the desired part of the larynx. The writer well remembers a young sailor of splendid physique who had a small fibroma situated well forward on the left vocal cord. Under ether a most trying and humiliating examination followed. Success, however, followed when a small bronchoscope was introduced from the angle of the mouth on the right and carried into and across the larynx until the growth was pinned inside the tube and against the lateral wall of the larynx. An assistant meanwhile pressed the larynx backward and made counter-pressure on the left.

A working set of instruments for bronchoscopy is as follows:

1. Jackson's tubular speculum (adult and child size).
2. Jackson's bronchoscopes (7, 8.5, 10, and 12 mm. in diameter).
3. Brünings' universal electroscope.
4. Brünings' extension double tubes (7, 8.5, 10, 12, and 14 mm. in diameter).
5. Brünings' autoscope or split spatula speculum (11 and 13 mm. in diameter).
6. Brünings' extension forceps with five different tips; or Jackson forceps with tips; or Coolidge forceps with shaft of three lengths and tips.
7. Suction apparatus (hand bulb, hand or electric aspirator, with three tubes 25, 35, and 50 cm. in length).
8. Foreign body hook.
9. Casselberry's pin cutter; or Mosher's pin bender.
10. Brünings' or Mosher's safety pin closer.
11. Jackson's dilator for the bronchi.
12. Mosher's adjustable speculum.
13. Two angular locking forceps, for use with the open speculum (Mosher).
14. Twelve Coolidge's cotton carriers.
15. Kirstein's head light.
16. Angular laryngeal knife.
17. Ring punch, for work about the mouth of the esophagus (Mosher).

This list includes instruments for obtaining light in three different ways. The head mirror and a standing electric lamp furnish a fourth. The latter is an easy method of obtaining illumination for the larynx and the mouth of the esophagus. It is economy to have all four in the operating room. The writer has his examining table in a special room which is given up to bronchoscopy and esophagoscopy. The table

(Fig. 116) stands on a platform the left corner of which is cut out to allow standing room for the operator. On this platform beside the examining table there is room for the etherizer and the assistant who holds the head of the patient. On the right on a wall bracket is a Coakley rheostat. Below this is another shelf for the Jackson double dry cell battery, and on the platform is an electric light on an upright stand. On the right also is placed an electric aspirating pump. Each piece of apparatus is connected with its own socket. A Kirstein head light is kept at hand. In the complete operating room there should be an illuminated box with a ground glass face for holding and demonstrating X-ray plates.

The table for instruments is placed behind and to the right of the operator. Beside the table and behind and on the right stands the first assistant. Opposite the first assistant but on the other side of the

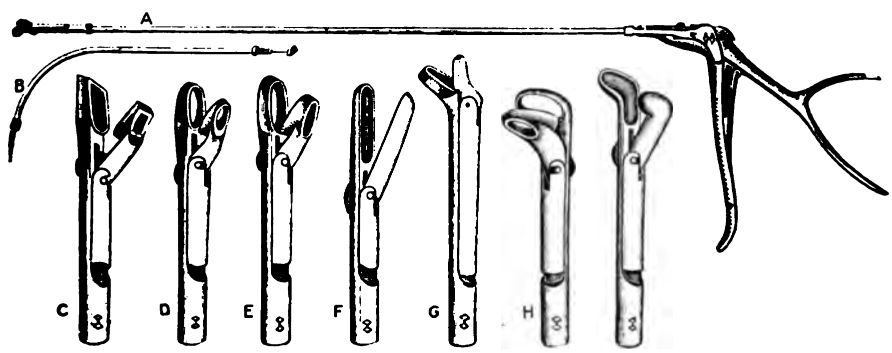


Fig. 119.
Forceps for direct work upon the larynx. (Pfau.) Various tips (natural size) are shown below the forceps.

table is the nurse. It is the duty of the nurse to load the cotton carriers. She should see to it that a good number of these are always ready so that the operator may never have to wait. The swabs are loaded either with cotton or better with small pieces of selvedged gauze cut and folded to the proper size. It is of the utmost importance that the nurse and the first assistant should know how to fasten the swabs securely to the carriers. When the operator is looking down a tube he should not be required to turn his head in order to receive an instrument. When he asks for one the first assistant not only passes it to him over his shoulder but places the end of the instrument in the mouth of the tube and its handle in the hand of the operator.

Before beginning the examination all instruments should be tested and proved to be in working order. Extra lights should be on hand; or what is better, if the Jackson bronchoscope is used, an extra light

carrier with a tested light should be in readiness. The assistants should know how to change the lights and how to adjust the instruments.

Every detail should be provided for before the examination is begun. The operator must be willing to supervise the smallest details if he wishes the examination to go quickly and smoothly. The success of the operation often depends upon the thoroughness of the preparation.

On an accessory table the instruments for tracheotomy should be sterilized and ready for use. There should be enough assistants for carrying out this procedure and they should be surgically trained.

The Inhalation of Oxygen.—A cylinder of oxygen gas should be in every operating room for use in cases calling for bronchoscopy. The administration of the gas may make it possible to avoid a tracheotomy if severe dyspnea is present, while the use of the gas to combat shock and respiratory arrest is important. If a bronchoscope is in place when the emergency arises the gas may be administered through this directly, or through the suction tube if the Jackson type of bronchoscope is employed. Daeger has devised an apparatus by which the amount of oxygen administered can be accurately measured and controlled.

Suspension Laryngoscopy.

About three years ago Killian introduced suspension laryngoscopy. Within the last twelve months his perfected instruments have begun to be used extensively. The underlying principle of the procedure is the transference of the weight of the patient's head from the hand of the examiner to the handle of the speculum. This gives the physician a new hand, his left, with which to work. The suspension is accomplished by elongating the handle of the speculum, and ending it in a hook. To this handle is attached a skeleton mouth-gag. A nut and a screw in the handle of the speculum control the width of this. A second nut and screw elevate the tip of the speculum. Spatulæ of different sizes are fitted upon the handle. Each of these has incorporated in it a narrow secondary spatula. The position of the tip of this is again regulated by a nut and screw. The apparatus is efficient and beautiful, but complicated. The claim is made for it that besides holding the patient's head it will always bring the anterior commissure of the larynx into view. The writer's experience with the apparatus as yet is too limited to pass on such a statement, but from what he saw at Killian's demonstration in London in 1913, and from what he has learned from the men in this country who have employed the method and Killian's instruments extensively, he considers this state-

ment much too broad. This is relatively a small matter, of course, because there will always be a percentage of cases in which neither a speculum nor the human hand can force the anterior commissure back into the field of vision. The gist of the matter is that an advance has been made, how great time alone can settle, by the introduction of suspension. The tired laryngologist eagerly grasps the relief which it affords. (Fig. 120.)

The way having been shown by Killian, the rest of the world of

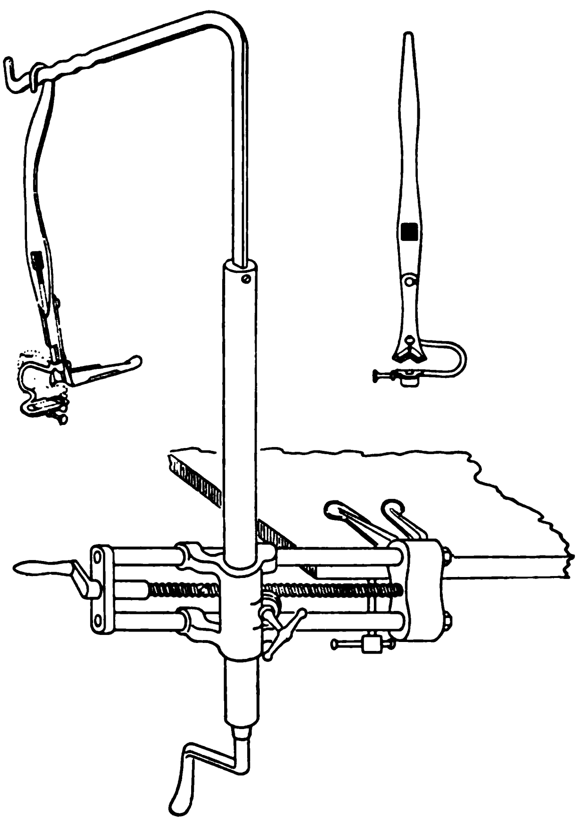


Fig. 120.
Killian's suspension apparatus.

laryngologists will rush in with possible improvements of the apparatus, aiming especially to simplify it. The writer admits that he is one of those who have made such an attempt. A hook in the end of the handle of his adjustable speculum, one nut and angle lever in the shank, and a set of cross ridges on the moving blade convert it as experience has shown, into a serviceable suspension speculum. It can be hung from a chain attached to the ceiling or as Murphy suggested,

from the frame of an adjustable instrument tray holder. The reader will doubtless think of other ways. The crane of Killian is efficient, of course, but it is bulky and does not fit every table. For convenience in carrying the writer has had a folding frame constructed. The board which supports this slips under the back of the patient. So far it has met expectations. (Figs. 121 and 122.)

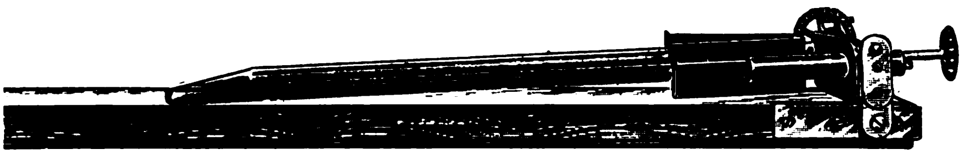


Fig. 121.
Mosher's folding frame for suspension apparatus closed.

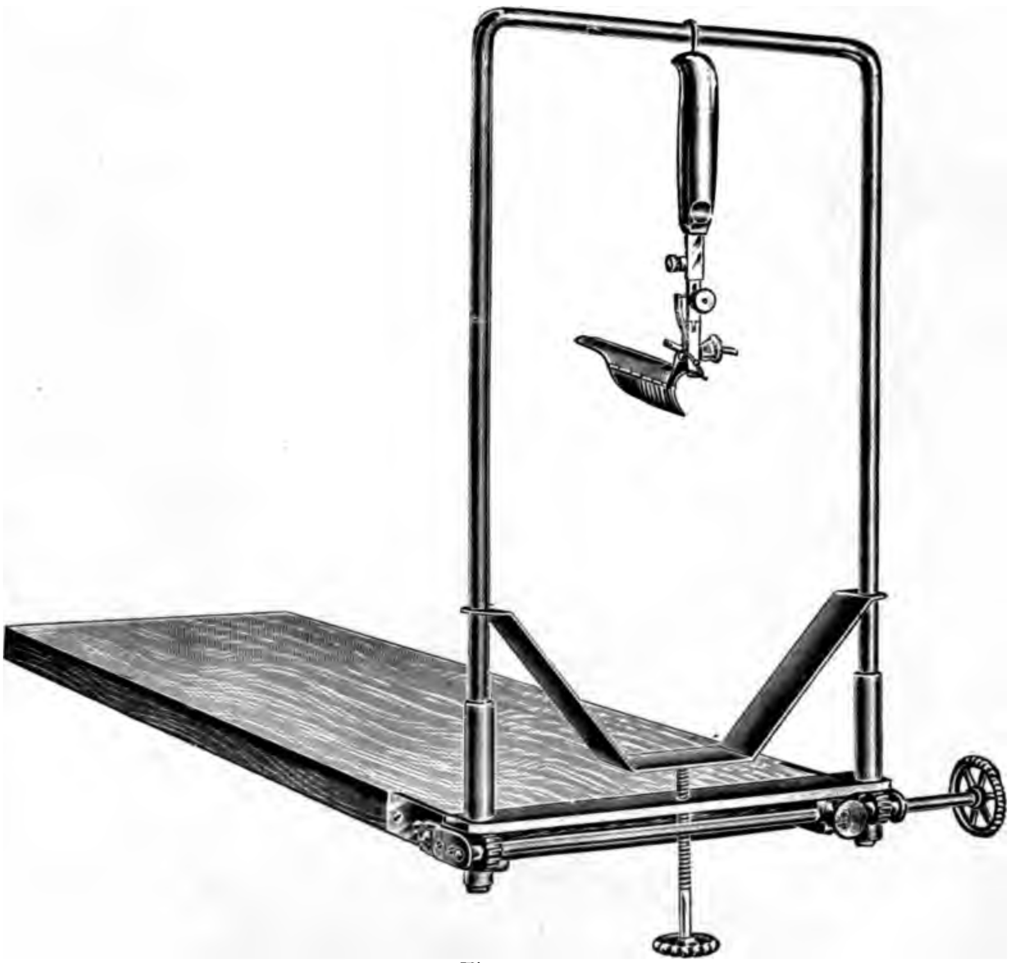


Fig. 122.
Mosher's folding frame for suspension apparatus open.

TRACHEOBRONCHOSCOPY.

The direct examination of the trachea and the bronchi can be carried out by two routes. By the upper route the tube is inserted between the vocal cords. When the lower route is employed the tube gains access to the trachea through a tracheotomy wound. After the performance of the tracheotomy the second method is the simpler and so will be described first.

Lower Tracheobronchoscopy.

Unless the lower route is used for the extraction of a foreign body it is well to wait a few days until the surgical wound has healed a little

Fig. 123.
Urethrascope used as a tracheoscope.

before attempting thorough examination of the trachea and the bronchial tree. The earliest examinations of the trachea by the lower route were made through short tubular specula like the female urethrascope, and the illumination was obtained from a head mirror (Coolidge.) At the present time self-lighted specula of this pattern are made. (Figs. 123 and 124.) For the examination of the trachea as far as the bifurcation these are the simplest and best instruments.

Contraindications to Lower Tracheobronchoscopy.—Unless tracheotomy is contraindicated the performance of lower tracheobronchoscopy is permissible except in the presence of pneumonia.

Anesthesia.—After a recent tracheotomy in a case in which the mucous membrane is normal, a drop of ten per cent cocain with adrenalin added, placed in the trachea is sufficient to produce anesthesia. Only in the region below the glottis is there excessive sensitiveness. The trachea tolerates the tube well. After the insertion of the tube the

Fig. 124.
Urethrascope used as a tracheoscope, showing individual parts.

swab syringe may be used to apply cocain to the walls of the trachea, the most sensitive part being the anterior wall. In patients who have been wearing a tracheal canula for some time the mucous membrane about the tube is very irritable and it may be impossible to cocainize it. In children the strength of the cocain solution should be reduced to five per cent and in adults in the presence of bronchitis a twenty per cent solution should not be used or should be employed sparingly. If there is a foreign body in the trachea, the cocainization should be accomplished with a syringe, not with a swab. The parts of the trachea

which are the most irritable are the neighborhood of the fistula, the bifurcation, and the bronchi below. The inflamed mucous membrane about a foreign body is always sensitive.

Position of the Patient.—Lower tracheobronchoscopy is easiest when performed with the patient sitting. After a fresh tracheotomy or if the patient is weak, the prone position is better. When a search is to be made for a foreign body the patient should be examined on his back and with the head lowered. If the prone position causes coughing or interferes with the breathing the erect position of the patient is the only choice. Better control is obtained with children if they are placed on the back.

In some cases the examination succeeds best if the head of the patient is extended over a roll or if a sandbag is placed under the neck, as is customary in the performance of tracheotomy. In other cases the head is held over the end of the table.

The Method of the Examination.—The ideal method of learning bronchoscopy is to make use of a patient who has had a tracheotomy performed.

The introduction of the examining tube offers some difficulty unless it is done at the time of the tracheotomy when the tissues of the neck are wide open, and the tracheal incision can be spread with retractors. (Figs. 123 and 124.) After the complete healing of the wound about the tracheotomy tube the fistula into the trachea is more or less oblique, and is always narrowed from its original dimensions. The easiest way to insert the tube without abraiding the edges of the fistula is to place a snugly-fitting elastic bougie through and beyond the tube, and then after having inserted the projecting end of the bougie through the fistula and well into the trachea to push the tube down on the bougie. The bougie guides the tube into the trachea and keeps it from striking the posterior wall and centers it in the long axis of the trachea. (Coolidge.) Naturally the posterior wall of the trachea is the easiest to examine. The side walls offer some difficulty but the anterior wall, especially in the neighborhood of the fistula, is the hardest of all to inspect. In order to accomplish this the patient's head must be turned strongly to one side so that the tube can be made to lie flat with the neck.

If, instead of inserting the tube downward, it is inserted into the trachea with the point upward, the beginning of the trachea and the subglottic region of the larynx may be examined. Such an examination may be called for in cases of adhesions between the cords after diphtheria or when there is subglottic narrowing due to the contraction of scar tissue. This method is called retrograde examination. For

this procedure smaller tubes are necessary in order that the breathing may not be interfered with.

To return to the direct examination of the lower part of the trachea. If it is possible to employ a large tube, just as soon as this is well engaged in the lumen of the trachea the observer usually can see the whole of the trachea to the bifurcation. It may be necessary occasionally to draw the tube to one side in order to accomplish this. The color of the trachea varies in different patients from a yellowish to a blood-like red. If the walls of the trachea are painted with adrenalin solution less light is absorbed and the illumination is increased. The tube slips down the trachea almost of itself and the beginner, often, un-

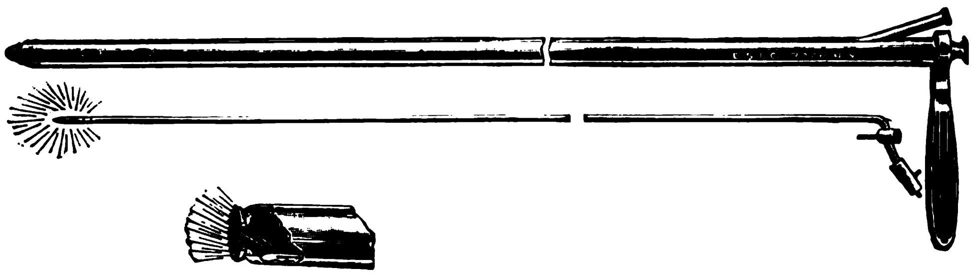


Fig. 125.
Jackson's bronchoscope.

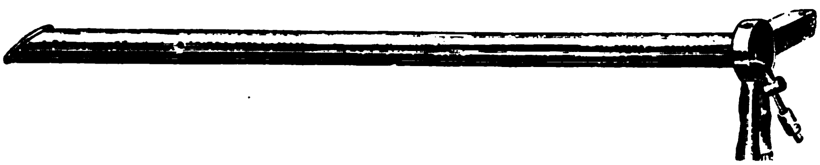


Fig. 126.
Jackson's bronchoscope, with beveled end.

less he keeps his bearings by moving the tube from side to side, misses the bifurcation and carries the tube into the right main bronchus. In this connection it should be borne in mind that the median septum is often pushed far to the left. The septum should always be located before the tube is passed into a bronchus.

The Endoscopic Picture.—In a tubular organ like the trachea having a constant lumen, when the observer looks through the bronchoscope he sees at some distance ahead of the end of the tube the lumen of the trachea and its walls. (Figs. 125 and 126.) The beginner is liable to introduce the tube too far at first and not to get the picture in perspective. If this is done pathologic narrowing of the lumen would not be recognized. The same would be true of any deformity of the walls caused by pressure of the neighboring organs. In order to ob-

tain a proper perspective the tube should be held high, but for a good view of the walls the tube should be carried well down and as near to the wall to be examined as possible. The higher the tube the larger the field which appears in perspective beyond it, the deeper the tube the smaller and clearer the field. In order to obtain a clear picture of the walls the tube should not only be introduced well into the trachea, but the end should be displaced strongly to the side. The trachea

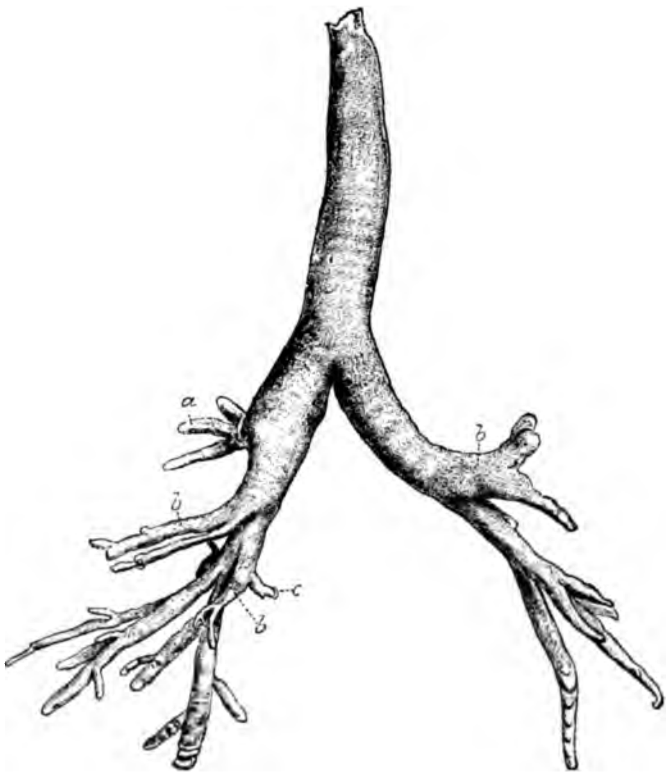


Fig. 127.

Cast of the interior of the trachea and bronchi, with their chief ramifications within the lung. This cast shows a type of division frequently met with, the right bronchus being almost in continuation of the line of the trachea. *a*, eparterial branch; *b*, *c*, hyparterial branches (ventral and dorsal). (Quain, after Aeby.)

and the bronchi are so movable that this procedure is constantly practiced. Indeed, the movability of the bronchial tree is as important for the success of bronchoscopy as is the forward dislocation of the base of the tongue for the performance of direct inspection of the larynx. In bronchoscopy the observer should look ahead of the tube. The eye should precede and guide the tube and the hand.

The elasticity of the bronchial tree makes the lateral displacement by the examining tube painless. The lateral mobility of the

bronchial tree is utilized to the greatest extent in bringing the first branch of the left main bronchus into view. In addition the tube is placed in the corner of the mouth and the head of the patient is bent sidewise toward the operator. The median septum of the trachea and the great vessels suffer in this manipulation a displacement of 5 cm., and the bronchi and neighboring structures a dislocation of 10 cm.

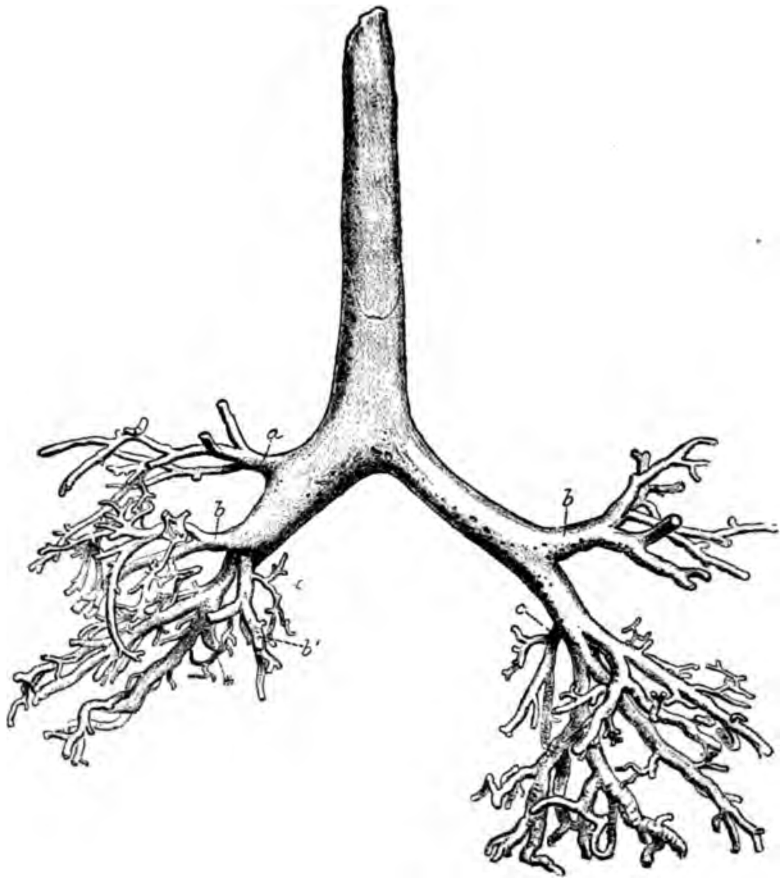


Fig. 128.

Cast of the interior of the trachea and bronchi, with their chief ramifications within the lung. This cast shows a type of division less frequent than the last, the right and left bronchi being at about a right angle with one another. *a*, eparterial branch; *b*, ventral hyparterial branches; *b'*, accessory (azygos) branch; *c*, dorsal hyparterial branches. (Quain, after Aeby.)

The angle which the tube makes with the long axis of the body is 30°. (Fig. 127.)

Much less displacement is required in order to introduce the tube into the third bronchus of either side. On the right, on account of the fact that the main bronchus is so nearly in line with the long axis of

the trachea, the lateral displacement sufficient to bring the bronchus to the lower lobe into view is about 1.5 cm.

In lower bronchoscopy even less lateral excursion is necessary. (Fig. 128.)

The Interpretation of the Endoscopic Pictures.—The greatest dif-

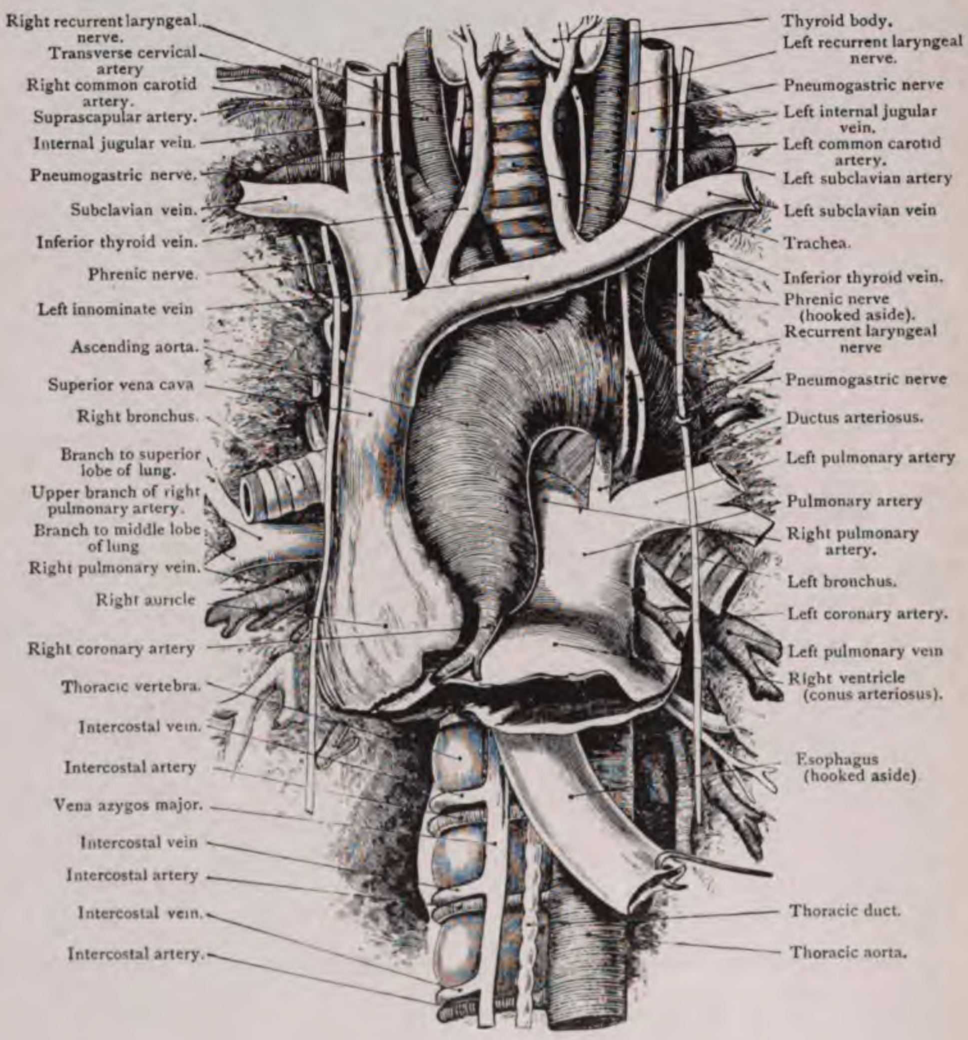


Fig. 129.

The arch of the aorta, with the pulmonary artery and chief branches of the aorta. (Morris' Anatomy—From a dissection in St. Bartholomew's Hospital Museum.)

ficulty which the observer encounters is to judge the perspective rightly. As he looks with one eye he is without the aid of the parallax which binocular vision affords and is constantly mistaking his distance. In

the trachea the observer can help himself by counting the rings. In the main bronchi measurements are of more aid. The greatest help of all is obtained by laying the mandrin of the examining tube on the surface of the chest and judging the internal distances from this. (Fig. 129.)

The length of a stenotic area is hard to determine by sight, and is best made out by the use of a metal olive tipped bougie. Objects at the end of the tube appear smaller than they really are. Their true

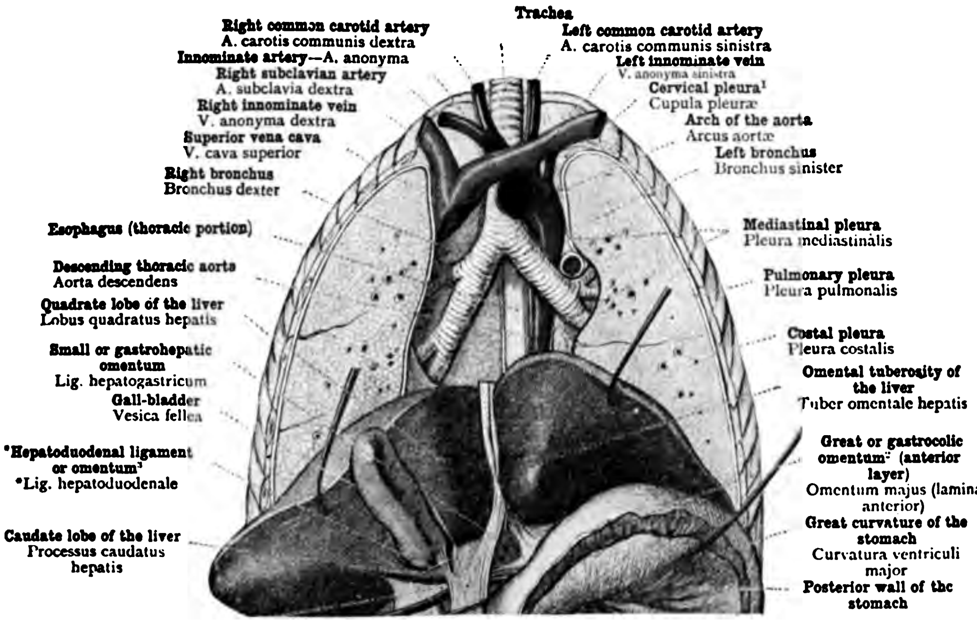


Fig. 130.
Showing the relation of the trachea to the great vessels of the neck. (From Toldt.)

size can be reckoned mathematically, but it is easier to obtain it by measuring a duplicate of the object. (Fig. 130.)

The Choice of the Upper or the Lower Route.—For the beginner lower bronchoscopy is easier and safer. In infants and young children it is safer and often the method of choice. The experienced operator will succeed with upper bronchoscopy where the novice will fail, but it is well to try upper bronchoscopy as a routine in all cases. If it does not succeed the operator should not hesitate to abandon it for the lower route. There is no disgrace in so doing. It has been proved that in cases in which a foreign body, like a bean, has been playing up and down in the trachea for some time the trauma so caused often produces spasm or edema of the larynx, so that after upper bronchoscopy, even

if it has been successful, an emergency tracheotomy may be necessary. The question of upper or lower bronchoscopy should never depend on the pride of the operator but on the good of the patient.

The Dangers of Bronchoscopy.—Operative bronchoscopy is naturally more dangerous than examinations merely for diagnostic purposes. Jackson's statistics of ninety-four cases of upper and lower bronchoscopy give a mortality of two per cent. The chief danger of the examination is its length. Under ether three-quarters of an hour is a safe limit. Rather than prolong the operation it is better to try again at a second sitting. In one of Killian's cases of a foreign body

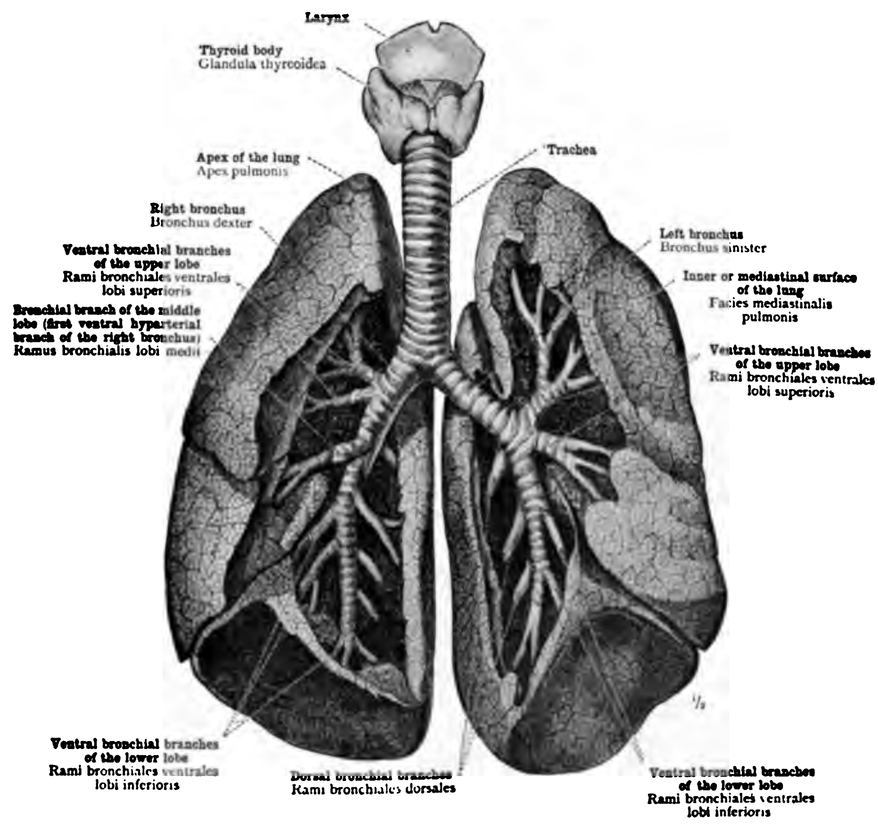


Fig. 131.
Showing the divisions of the trachea and bronchi. (From Toldt.)

in the bronchus ten sittings were required before the extraction was successful, and many of these lasted two hours. Brünings gives the time of the ordinary operation as five to fifteen minutes. Jackson has reported the removal of three tacks in three minutes. (Fig. 131.)

Asepsis.—In bronchoscopy the mouth of the patient should be made as clean as possible. Jackson advises a thirty per cent solution of alcohol as a mouth wash. It goes without saying that the instru-

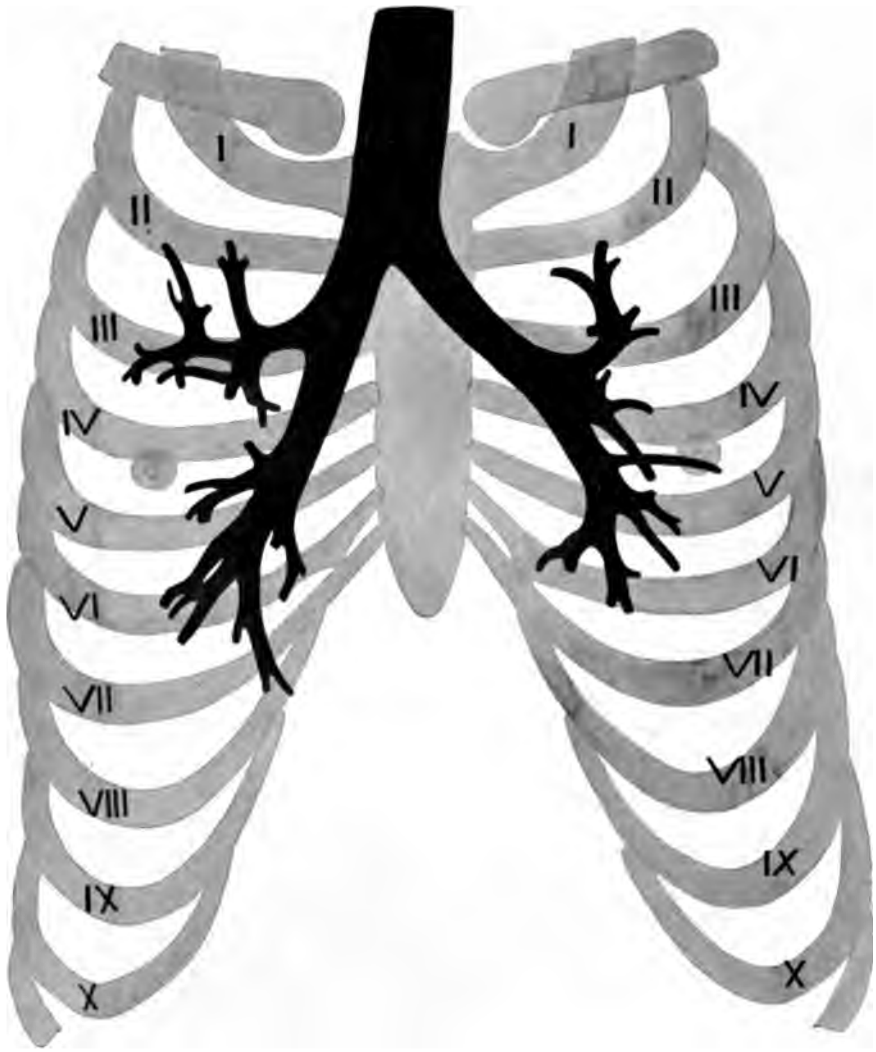


Fig. 132.
Showing the relation of the main bronchi to the ribs and the chest wall (Anterior view). (From Anatomical Department, Harvard Medical School.)

ments also should be clean. Generally immersion in seventy per cent alcohol is depended upon for the sterilization. Formalin vapor can be employed if preferred.

The Size of the Tubes.—Brünings uses tubes of four sizes.

UPPER BRONCHOSCOPY.

Number	Size	Age
1	7 mm.	1 to 3 years.
1½	7½ mm.	4 " 5 "
2	8½ mm.	4 " 9 "
3	10 mm.	9 " 14 "
4	12 mm.	Adults (men and women).

LOWER BRONCHOSCOPY.

Number	Size	Age
1	7 mm.	1 to 3 years.
2	8½ mm.	3 " 8 "
3	10 mm.	8 " 14 "
4	12 mm.	Adults (men and women).

BRONCHOSCOPY.

In order to see the secondary bronchi the main bronchus is dislocated laterally and the tube brought into line with the bronchus to be examined.

The patient's head must be bent in the proper manner to allow this change in the position of the tube. In changing the position of the head the neck should not be held far backward and cramped because this interferes with the mobility of the trachea and the bronchi.

As soon as the lumen of the right main bronchus is entered and lighted by the tube, the observer sees in the distance the opening of the bronchus to the lower lobe and within this smaller dark, oval patches which are the openings of the tertiary bronchi. Between these dark patches appear the median septa. The picture constantly changes. With every movement of the tube new openings of new branches come into view, in the depths of which other divisions are seen. (Fig. 133.) In the deeper bronchi there is a rhythmical change of the picture with respiration.

When the tube is placed high in the main bronchus the opening of the branch to the upper lobe as well as of that to the middle lobe generally are not seen. It is only after inserting the tube to the proper depth and dislocating the bronchus between one and one and five-tenths cm. to the side and upward, that the lower circumference of the opening of the branch to the upper lobe is discovered. If the manipulation is not successful the tube is inserted below the origin of the first branch and lateral pressure is made as before and the tube withdrawn. As the tube comes up the opening of the bronchus springs into view. (Fig. 134.)

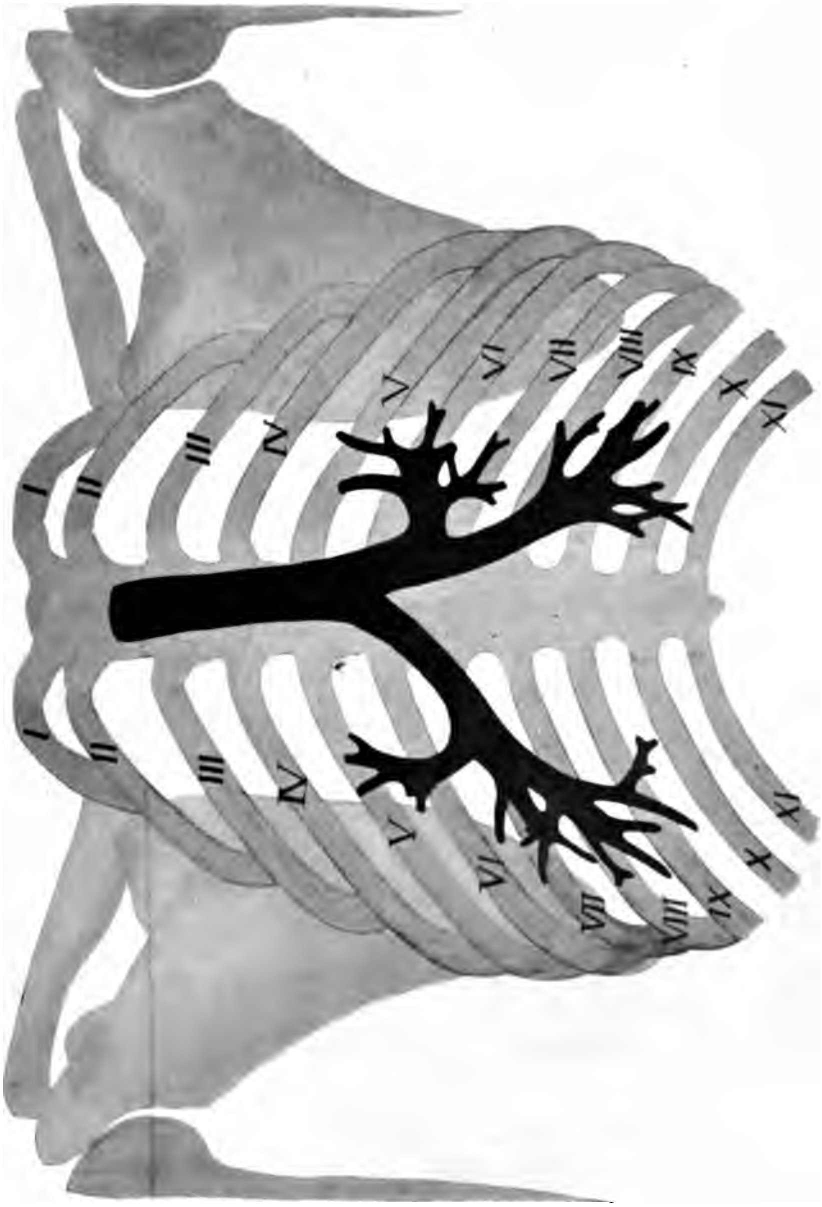


Fig. 133.
Showing the relation of the trachea and main bronchi to the chest wall and ribs (Posterior view). (From Anatomical Department, Harvard Medical School.)

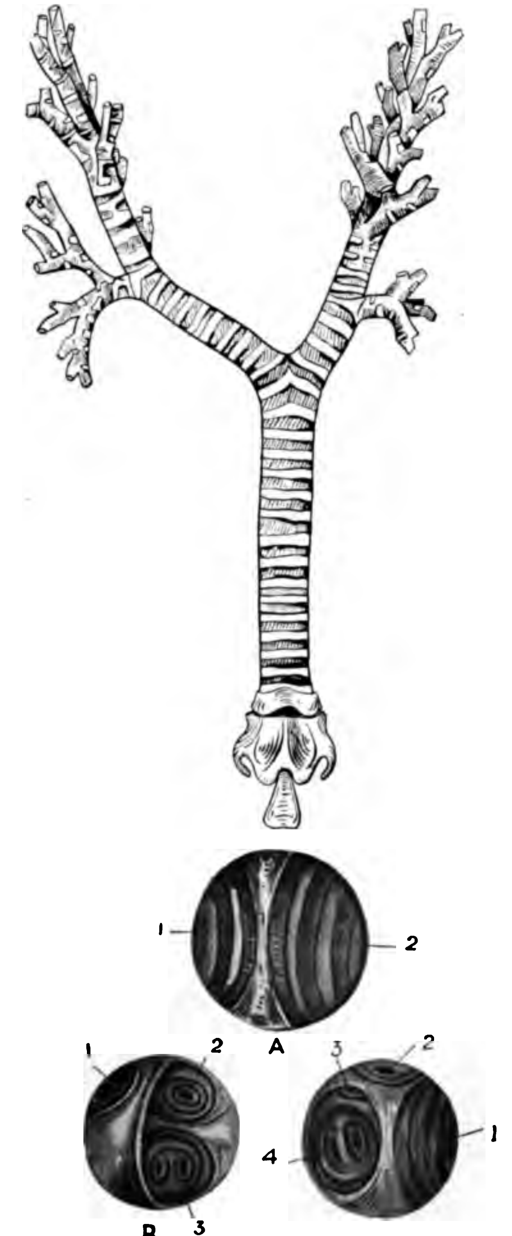


Fig. 134.

Diagram to show the bronchoscopic picture. (After Jackson.)

A. The bifurcation of the trachea is shown to the left of the middle line. 1. Left main bronchus. 2. Right main bronchus.

B. Picture of the left main bronchus (see Fig. 128). 1. Bronchus to upper lobe. 2.-3. Bronchi to lower lobe.

C. Picture of right main bronchus. 1. Bronchus to upper lobe. 2. Bronchus to middle lobe. 3-4. Bronchi to lower lobe. No. 4 is the practical continuation of the right main bronchus.

In lower bronchoscopy the opening of the branch to the upper lobe is easier to find. So readily can the opening be approached that the circumference of the first two rings can be made out. The field often increases rhythmically with the respiration.

The cavity of the branch to the upper lobe can be explored by placing a small mirror through the examining tube into the bronchus or by inserting a small cystoscope. With the latter Brünings has demonstrated even the tertiary bronchi. The cystoscope should have a diameter of 8 mm. and if designed for both upper and lower bronchoscopy it should be about 30 cm. long.

Although cases have been reported of foreign bodies lodged in the branch to the upper lobe (Wild and Gottstein), as a rule such cases are rare. Killian calls attention to the fact that the examination of this branch might give a clew to tuberculosis of the right apex, that is, pus might be seen coming from the opening of the bronchus in such cases. (Fig. 134.)

The direct examination of the branch to the middle lobe is easily accomplished when the tube is carefully introduced and pressure is made in a forward direction. This opening, however, can be readily confused with that of the branch

to the lower lobe. In all cases in which the observer is in doubt the tube should be withdrawn to the bifurcation and then carried downward again step by step.

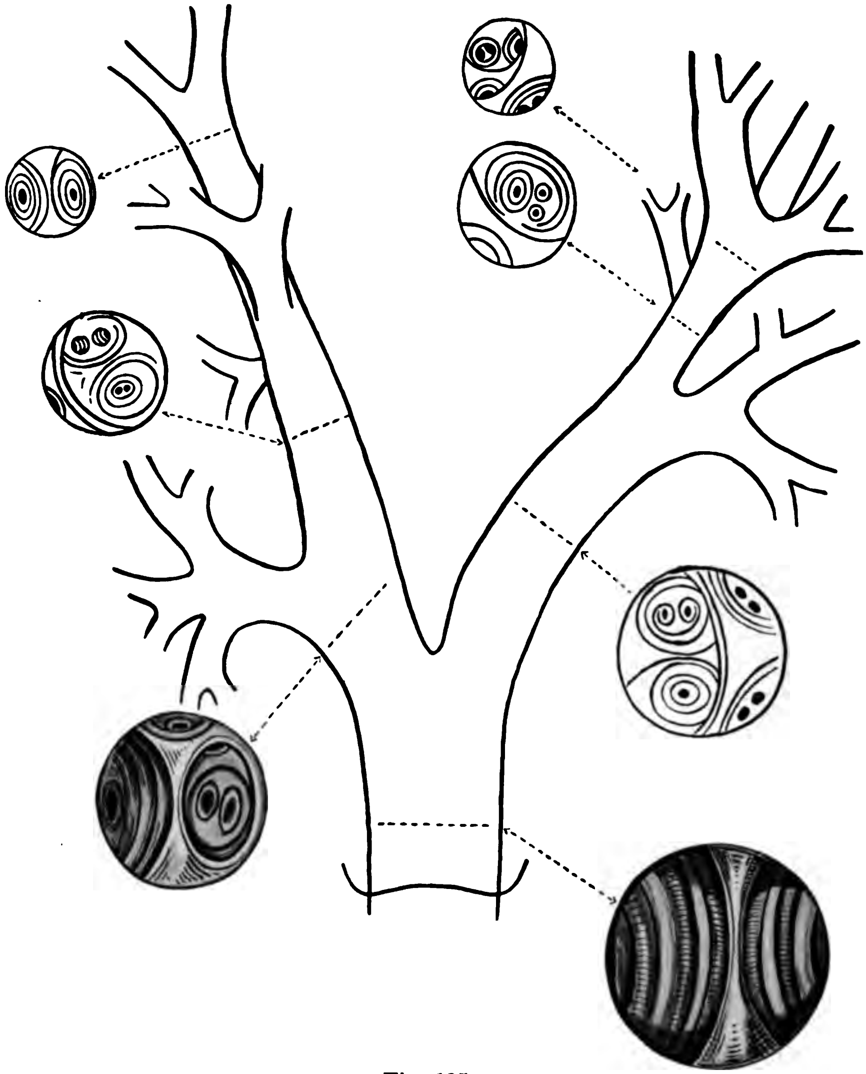


Fig. 135.
Diagrammatic drawing to show the bronchoscopic picture at various levels.

The branch of the right main bronchus to the lower lobe is really a continuation of the main bronchus. For this reason the opening of the third secondary bronchus is not only easy to see and enter with the tube but this is the bronchus which most often catches foreign bodies. (Fig. 135.)

The left main bronchus leaves the trachea much more sharply than the right bronchus does. For this reason it is harder to gain access

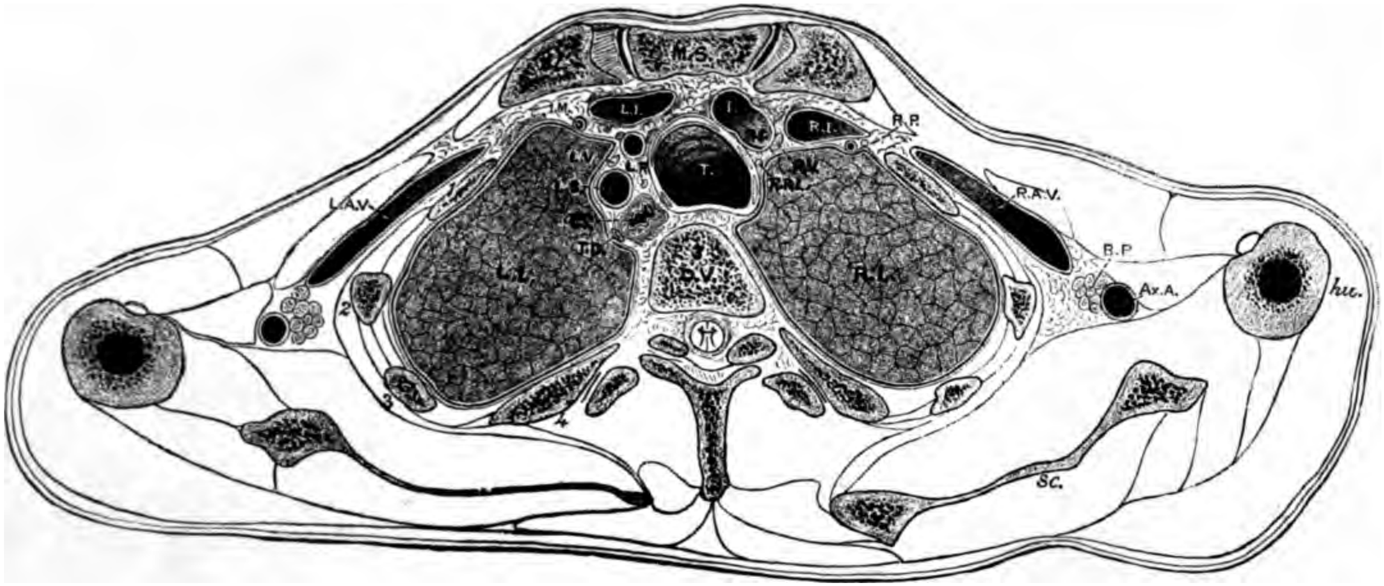


Fig. 136.

Horizontal section of thorax of man, aged 57, at the level of the upper part of the superior mediastinum, seen from above. (From Quain.)

3 D. V., body of third dorsal vertebra; M. S., manubrium sterni; *cl.*, clavicle; *sc.*, scapula; *hu.*, humerus; 1, 2, 3, 4, corresponding ribs; R. L., L. L., right and left lungs; T., trachea; ES., esophagus; T. D., thoracic duct; I., innominate artery; R. S., right subclavian artery; L. S., left subclavian artery, in front of this, not lettered, left common carotid artery; I. M., internal mammary artery; Ax. A., axillary artery; R. I., L. I., right and left innominate veins; R. A. V., L. A. V., right and left axillary veins; R. V., L. V., right and left vagi nerves; R. P., right phrenic nerve, the left phrenic nerve is on outer side of left common carotid artery; L. R., left recurrent laryngeal nerve; R. R. L., right recurrent laryngeal nerve; B. P., brachial plexus.

to it and to bring its branches, especially the first, into view. This bronchus is easier to see by lower bronchoscopy. In investigating the left main bronchus strong pulsations from the arch of the aorta are noticed. (Fig. 136.)

The origin of the branch of the left main bronchus to the upper lobe is 4 to 5 cm. from the bifurcation. It is to be found on the lateral wall and somewhat anteriorly. It is often missed both on the inser-

Fig. 137.

Horizontal section of thorax of man, aged 57, immediately above the bifurcation of the trachea, seen from above. (From Quain.)

U. L., upper lobe of right lung; U. P., L. L., upper and lower lobes of left lung; R. B., L. B., origin of right and left bronchi, in this specimen the termination of the trachea was lower than usual; A., arch of aorta; D. A., descending aorta; D., obliterated ductus arteriosus; N., left recurrent laryngeal nerve; L. G., lymphatic glands; other letters as in Fig. 136.

tion and on the withdrawal of the tube, and a sight of it is to be gained, if at all, by strong lateral and upward dislocation of the main bronchus and with the end of the tube held as obliquely to the lateral wall as possible. Naturally foreign bodies do not often gain entrance to this bronchus. (Fig. 137.)

On the left the second branch of the main bronchus, the bronchus to the lower lobe, is for all intents and purposes a continuation of the main bronchus. The tube, therefore, finds it readily and the picture seen through the tube shows the lumen of the third branch and then the division into the dorsal and ventral branches.

Lower bronchoscopy carried out as has been indicated is not difficult. The bronchi should be examined both on the introduction of the tube and on its withdrawal. The examination cannot be considered complete unless both main bronchi, the secondary bronchus on the right to the middle lobe and the branch to the lower lobe on both sides have been examined. The exploration of the two main bronchi and the branch to the lower lobe on the right is especially demanded because foreign bodies often lodge in them. In the author's experience foreign

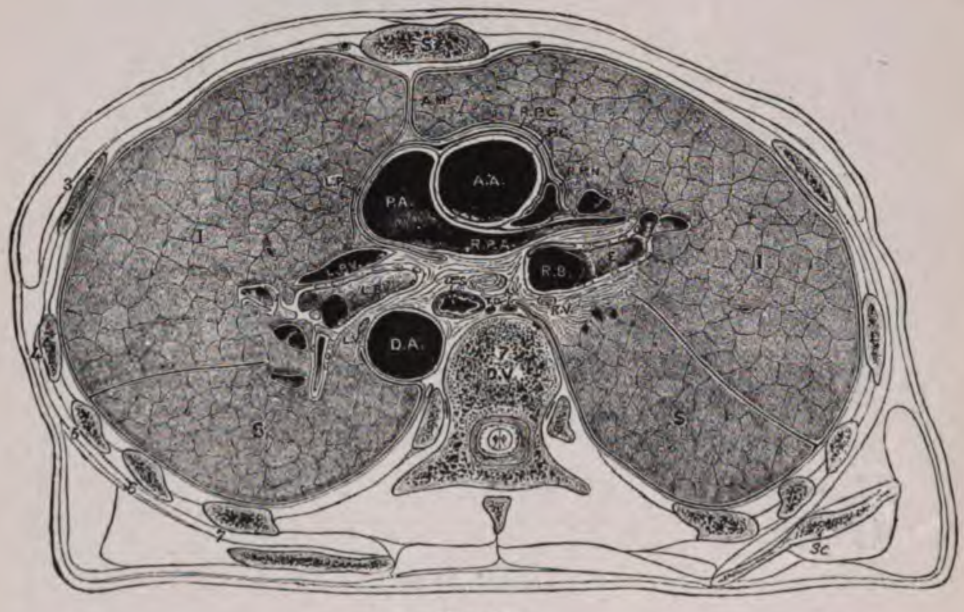


Fig. 138.

Horizontal section of the thorax of a man, aged 57, at the level of the roots of the lungs, seen from above. (From Quain.)

I. S., superior and inferior lobes of lungs; E., eparterial bronchus; A. M., anterior mediastinum; R. P. C., right pleural cavity; P. C., pericardial cavity; A. A., ascending aorta; P. A., pulmonary artery; R. P. A., its right branch; R. P. V., L. P. V., right and left pulmonary veins; A. V., azygos major vein; other letters as in Fig. 136.

bodies lodge oftenest at the bifurcation of the trachea, in the dilatation where the first branch of the right main bronchus comes off, or in the internal branch of the bronchus to the lower lobe.

The tertiary bronchi are so small that neither the bronchoscope nor light can be made to enter them. In such cases the use of a sound will enable the operator to palpate these small tubes even to the periphery of the lungs. (Fig. 138.)

Lower bronchoscopy is easier with the patient in the sitting position. It can and often is carried out with the patient lying on his back.

It is harder to manage the position of the patient's head if he is upon his back, because the handle of the electroscope often gets in the way. (Fig. 139.) With the Jackson tube, however, this difficulty is not encountered.

Upper Bronchoscopy.

Upper bronchoscopy is much more difficult than lower bronchoscopy on account of the more complicated technic required to insert

Fig. 139.

Horizontal section of the thorax of a man, aged 57, at the level of the nipples, seen from above. Note how the bronchi keep near the median line. This is fortunate in the removal of foreign bodies. (From Quain.)

n., nipple; M., middle lobe of right lung; R. A., right auricle; R. V., right ventricle; L. A., left auricle; L. V., left ventricle; R. V. P., right posterior valve of aortic orifice; *r. p. c.*, right pleural cavity; other letters as in Fig. 136.

the bronchoscope, due to the form of the larynx, and because of the slighter mobility of the tube and its greater length.

Anesthesia.—The German school are strong advocates of local anesthesia and the sitting position of the patient during the examination. In this country general anesthesia is used largely and the patient is examined lying on his back. The use of ether does away with the sense of hurry which attends bronchoscopy under local anesthesia.

The Method of Performing Upper Bronchoscopy.—If local anesthesia is to be employed the larynx of the patient is cocainized as for

direct inspection. The reflexes of the larynx are the most active. After the anesthesia has been accomplished the vocal cords are exposed. If Brünings' instruments are selected, this is done with the tubular spatula used after the fashion of his speculum, employed for direct inspection of the larynx. It is not necessary to expose the anterior commissure, so that the operator is content with disclosing the posterior third, or the posterior half of the cords. If this much is not readily brought into view, the assistant pushes the larynx backward.

The passage of the larynx is the difficult part of the manipulation. This is best accomplished by cautioning the patient to breathe quietly and regularly. When he does this the cords part in inspiration and the tube is slipped between them and into the trachea. The cords need not be widely separated. Sometimes it is necessary to turn the spatula-like edge of the speculum anteroposteriorly and to insert it in this manner between the cords and then to turn the speculum and force the cords apart. The introduction of the warmed and oiled tube is brought about not so much by force as by manipulation and a lever-like movement of the tube under the guidance of the physician's left forefinger.

The Introduction of the Bronchoscope with the Patient Lying on His Back.—Where the patient is placed on his back it is necessary for the introduction of the tube to have the head held over the end of the table. After the tubular speculum has passed the upper part of the epiglottis the head must be lowered for the exposure of the cords and the passing of the tube between them.

In the prone position of the patient the handle of the electroscope is somewhat in the way. This difficulty is not encountered if the Jackson tubular speculum is used because the speculum is discarded as soon as the bronchoscope has entered the glottis. If the introduction of the tube is difficult the patient may be turned on his left side. The tubular speculum is then carried in from the left corner of the mouth. The head is unsupported. The speculum easily passes into the trachea. After the speculum has entered the trachea the patient is turned upon his back again and the examination completed. The cords having been passed the rest of the examination is carried out as in lower bronchoscopy. When the tubular speculum has explored the trachea to the bifurcation the inner tube is inserted and advanced step by step to the main bronchi. Naturally it is not possible to move a tube when passed from the mouth as much as a tube introduced through tracheotomy wound. Therefore there is less lateral dislocation of the trachea and the bronchi. To make up for this loss the alteration or moulding of the patient's body, chiefly the position of his spine, is called into play. The bronchoscope is shifted to the corner of the mouth.

Upper Bronchoscopy with the Jackson Tubular Speculum and the Jackson Bronchoscope.—The tubular speculum of Jackson is very convenient for exposing the larynx and for introducing the bronchoscope. Jackson until recently has preferred to pass the bronchoscope under general anesthesia and with the patient lying on his back. Lately he has discarded both local and general anesthesia. The experience of the writer of this article has been obtained almost wholly with general anesthetics. After the cords have been exposed with the tubular speculum a bronchoscope of the self-lighting pattern and of appropriate size is passed through the speculum and between the cords. Then the separable hood is removed and the speculum withdrawn.

The Introduction of the Bronchoscope with the Open Speculum.—The introduction of the bronchoscope with the adjustable open speculum of the author is the simplest method of passing the bronchoscope under vision.

The Examination in Children.

Owing to the flexibility of the neck in the child and to the shorter distances, the direct inspection of the larynx in infants and children is often comparatively easy. The structures are diminutive so that the field obtained is small. The epiglottis is undeveloped and often very unruly when the speculum attempts to control it.

The difficulties in the examination of children arise from the smallness of the structures which necessitates tubes as small as 6-7 mm. Through these it is hard to get a good view and to manipulate instruments. In addition the examiner's difficulties are increased by the unruliness of the patient, by the tendency to spasm, by salivation, by the strong respiratory movements of the trachea and the bronchi, and lastly by the greater tendency to collapse either with local or general anesthesia.

In most cases bronchoscopy is undertaken in children for the detection and the removal of foreign bodies. Foreign bodies are most common in children, to summarize a table from Gottstein, between the second and the sixth year. Sixty-nine per cent of cases occur before the twelfth year, and only thirty-eight per cent from the twelfth year onward.

Instruments.—Relatively wider specula may be used in children than in adults. Forceps and all other instruments which are to be used through the diminutive tubes which are employed in children must be especially small in calibre. Brünings has a special form of electroscope which he advises for this work. Other instruments are the open speculum of Brünings, or that of the writer. A self-lighted urethrascope

is of service for use through a tracheotomy wound. The size of such tubes varies between 7 and 8 mm. The sizes of the urethrascopes should be 5, 6 and 8 mm. Seventeen cm. is a sufficient length for the forceps.

Direct Laryngoscopy.—The simplest way to examine a baby is to wrap it in a blanket and to place it on its back on a table and expose the larynx with the open speculum or the children's size of the Jackson speculum. The examination of the child held in a sitting posture in the arms of a nurse is also satisfactory. For this purpose the speculum is passed along the center of the tongue or introduced from the corner of the mouth. In infants and children the author has had no experience with local anesthesia. He prefers to use general anesthesia. Brünings gives the impression that examinations conducted in this way are less satisfactory than when local anesthesia is employed. It is doubtful if the experience of operators in this country accords with that of Brünings.

The Method of Examination.—The method of making the direct inspection of the larynx in infants and children is the same as in adults. The distances are very short and the epiglottis is placed high so that only a slight depression of the tongue is required to expose it. The pharynx and even the glottis often close in a sphincter-like fashion, and from time to time the whole working field is flooded with mucus. A speculum with a broad end is especially serviceable in raising the stubby and elusive epiglottis. Often the anterior commissure of the larynx can be moulded into view by external pressure. In holding the head it should not be bent too far backward.

Lower Bronchoscopy.—Lower bronchoscopy is carried out with children in the same manner as in adults. For the examination of the trachea in the neighborhood of the fistula the urethrascope or a small bronchoscope constructed on this pattern is of service. In examining the trachea and the bronchi the respiratory movements of the air passages are a great annoyance. In strong respiration the field may be lost altogether. This is embarrassing in the bronchi because if the mucous membrane is swollen it is only during inspiration that a view can be obtained.

Upper Bronchoscopy.—Upper bronchoscopy in children is the most difficult feat which is attempted with this procedure. The examiner should be ready and willing at any moment to supplant it by lower bronchoscopy.

The author has had most experience with upper bronchoscopy performed under general anesthesia. Small doses of atropin control the secretions. The introduction of the tube is easily accomplished in

the usual case with the small Jackson speculum or with the adjustable open speculum. Upper bronchoscopy in children should never be attempted without instruments and assistants enough for the execution of a rapid tracheotomy. The danger of subglottic swelling after bronchoscopy in children should always be in the mind of the operator. The patient may require an emergency tracheotomy not only during the operation but at any time during the next day or two.

The general conduct of the examination by the upper route is along the same lines as the examination in the adult.

Instruments for Bronchoscopy.

The essential instrument for the performance of direct inspection of the larynx, the trachea, and the bronchi, is a metal tube of appropriate size and length. For direct examination of the larynx the tubular speculum is constructed so that it is open for a part of its length. For the examination of the bronchi the speculum becomes a long tube. The speculum and the long tube can be lighted from within or from without. The simplest method of lighting the bronchoscope is that popularized by Jackson. A small secondary tube is carried along the side of the larger and the main tube to its lower end. At this point a window turns the lumen of both tubes into one. In the secondary tube a small rod-like tube acts as a carrier for a diminutive electric lamp. When the carrier is in position the lamp lies opposite the window and when the lamp is burning its light illuminates not only the end of the larger tube but shines ahead of it.

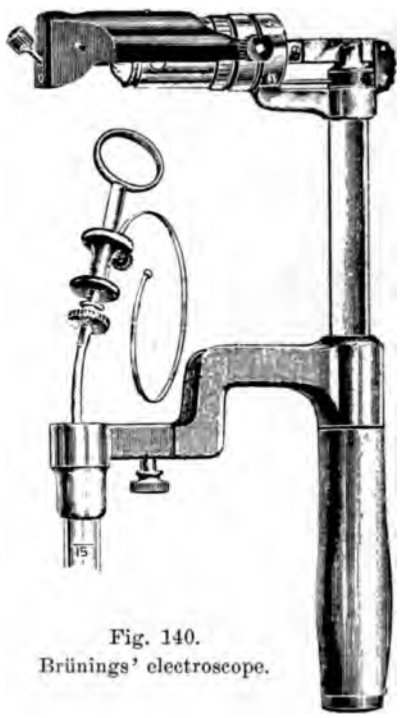


Fig. 140.
Brünings' electroscope.

The illumination of the tube by the second method is accomplished by attaching to a handle which can hold various sizes of tubes, a small but powerful electric lamp. (Fig. 140.) Above this a mirror is so placed that the light from the lamp is thrown down and through the tube. Brünings has developed this form of illumination to a high degree of efficiency in his various forms of electroscopes. Both methods of lighting the examining tubes are highly successful. Each has certain

advantages. The examiner should provide himself with both sets of instruments. He certainly should not allow himself to become so prejudiced as to be willing to use but one pattern.

The disadvantage of the self-illuminated tube is that the light is liable to become clouded with secretions and blood. It is surprising, however, especially if the examination is conducted under general anesthesia and the secretions controlled by atropin, how long the light will burn before it becomes dimmed. As a rule suction will keep it clean. Theoretically a strong case can be made out against the self-lighted tube in the presence of abundant secretion, especially blood, but the results of practical work refute most of the objections. The lights call for a little more care than the larger lamp of the Brünings electroscope. The thread of the small lamp and the thread in the light carrier should be carefully standardized so that new lamps will fit and burn. If this detail is attended to, the small lamps give almost no trouble. The great advantage of the self-lighted tube is that its handle is not complicated and so at times in the way, and that the eye of the observer has the full diameter of the tube to look and work through from the beginning of the tube to its end. This reduces the eye strain—the physician's eyes are his capital.

The advantage of illuminating the tube by reflecting light through it is that the illumination is never lost in the presence of secretions. A candid observer must admit, however, that it is more tiring to look through the narrow slit in the mirror of the electroscope than it is to look through the full lumen of the self-lighted tube. The author has read the discussions which deal with the question of lighting from the standpoint of optics, but has settled the question for himself at the examining table. The beginner in bronchoscopy is advised to do the same.

The Jackson Tubular Speculum.—The Jackson tubular speculum is shown in Fig. 113. This speculum is made in two sizes, the larger for adults and the smaller one for infants and children. The cut makes detailed description of the instrument unnecessary.

Johnston has modified the Jackson speculum by making the handle detachable.

The Brünings electroscope is shown in Fig. 140. It is made in at least three patterns. The author has found it necessary to provide himself so far with but one pattern.

The Brünings Elongating Bronchoscope.—The main tube is a long tubular speculum. This is used to examine the trachea as far as the bifurcation and the esophagus as far as the arch of the aorta. For ex-

amination beyond these depths a smaller tube is fitted into the larger one and carried down and beyond it by means of a stout spring. By this device the tube can be lengthened at will. This form of tube is especially useful in examinations performed under local anesthesia.

The Brünings Elongating Forceps.—Brünings has applied the principle of the elongating tube to his forceps. (Fig. 148.) This form of forceps is very useful especially as the shaft is fitted with tips adapted for all necessary manipulations. The operator should supply himself with a liberal assortment. It is vital to have a good tip for grasping, a tip made in the form of a punch, and a tip of the proper form for seizing beans and other seeds. Special cases call for special instruments.

Batteries.—The lamp in the Jackson speculum and bronchoscope is most conveniently lighted by a current obtained from dry cells. Jackson employs a double battery. After considerable experimenting the writer has found four dry cells controlled by a small rheostat the most portable, the easiest to renew and altogether the most satisfactory. (Fig. 141.) There are many forms of rheostats with which the ordinary street current can be used. These, however, are too bulky to carry about. The light in Brünings' electroscope calls for a reasonably powerful wall rheostat, such as is found in the equipment of the ordinary operating room.

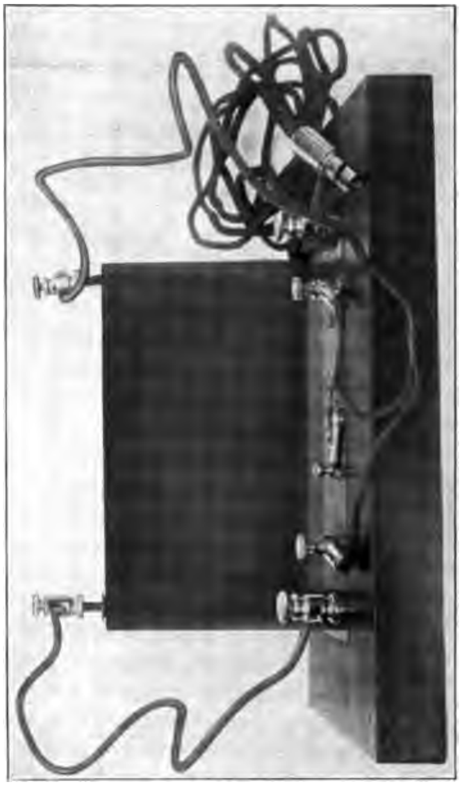


Fig. 141.

Rheostat and battery.

The author has found the small detached rheostat and four dry cells united as a unit the simplest way of obtaining the current to run the lamp of the bronchoscope. The batteries are easily obtained and readily connected with the rheostat. Batteries that come in cases often have to be sent to special dealers for refilling, so that there is delay in getting them.

In carrying a battery of this kind it is necessary to see that it does not become short-circuited in the instrument bag and its power exhausted. An amperemeter is used to test the battery before it is used. The physician always knows whether or not there is sufficient current.

Aspirator for Removing Secretions.—The Jackson bronchoscope has in addition to the sec-

ondary tube which carries the light a second auxiliary tube for the removal of secretions. A hand bulb may be used attached to the suction tube or an apparatus such as is employed for removing fluid from the chest, or best of all an aspirator run by electricity. Small amounts of secretion are removed by folded gauze swabs. The Coolidge cotton carrier is excellent for this purpose. (Fig. 142.) In direct examinations of the larynx, long angular forceps, the blades of which lock

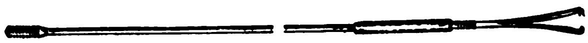


Fig. 142.
Coolidge's cotton carrier.

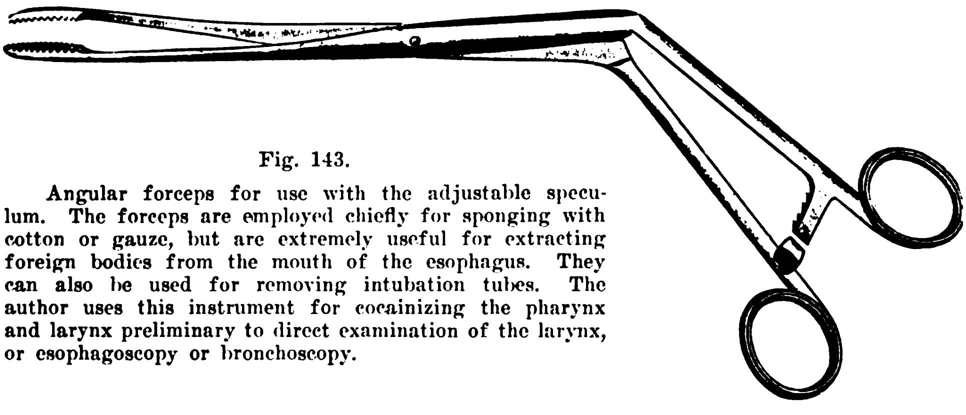


Fig. 143.

Angular forceps for use with the adjustable speculum. The forceps are employed chiefly for sponging with cotton or gauze, but are extremely useful for extracting foreign bodies from the mouth of the esophagus. They can also be used for removing intubation tubes. The author uses this instrument for cocainizing the pharynx and larynx preliminary to direct examination of the larynx, or esophagoscopy or bronchoscopy.

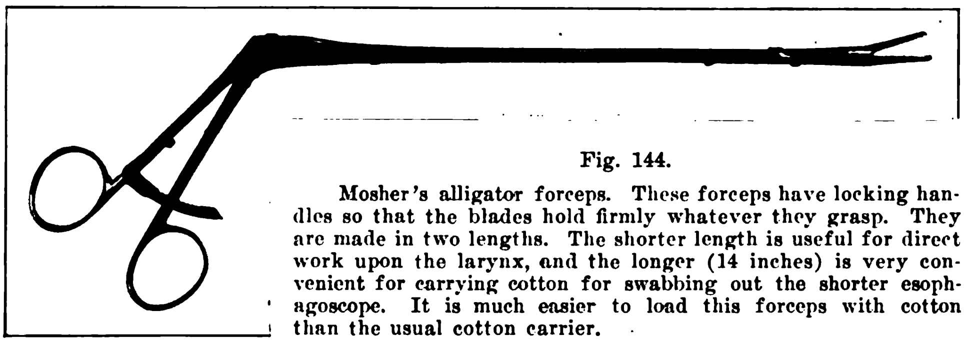


Fig. 144.

Mosher's alligator forceps. These forceps have locking handles so that the blades hold firmly whatever they grasp. They are made in two lengths. The shorter length is useful for direct work upon the larynx, and the longer (14 inches) is very convenient for carrying cotton for swabbing out the shorter esophagoscope. It is much easier to load this forceps with cotton than the usual cotton carrier.

(Fig. 143), are useful for removing the thick secretions in the pharynx. Long alligator forceps (Fig. 144), also with handles which lock, are a luxury when short tubes are used because it is very easy to replace the swabs. (Figs. 145 and 146.)

Acquiring Skill.—Brünings in his course to students drills the men in the extraction of foreign bodies placed in a rubber mannikin of the respiratory tract. Practice of this kind is very valuable. By it the beginner learns to see, and learns the best way of using the different

kinds of forceps. If Killian's mannikin (Fig. 147) is not at hand much the same kind of practice can be obtained if a foreign body is placed in a rubber tube. Foreign bodies may be placed in the air passages of narcotized dogs. The cadaver used for bronchoscopy gives both practice in removing foreign bodies and what is even more important, a

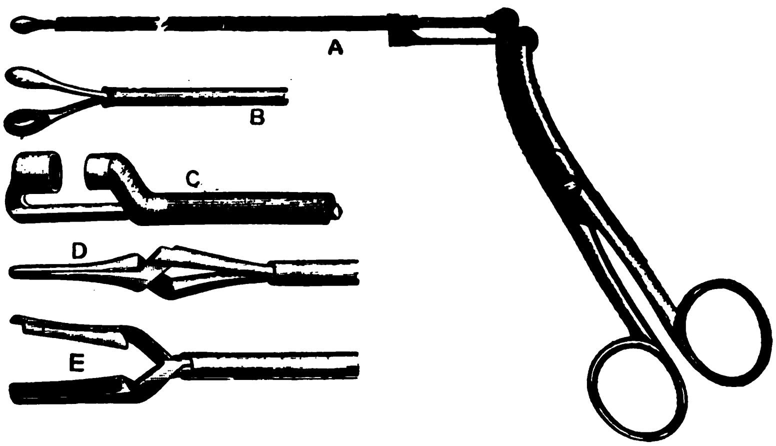


Fig. 145.
Jackson's tube forceps. B, actual size of tube and jaws of forceps; D and E, dilators for bronchoscopic strictures, which can be used in connection with Jackson's tube forceps handle.

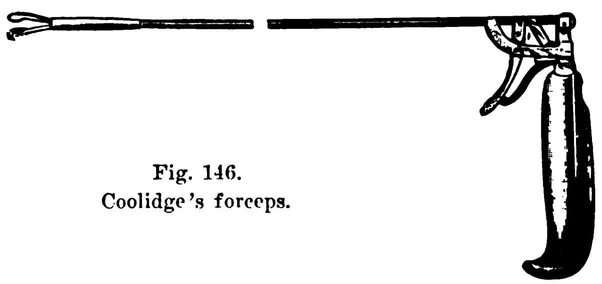


Fig. 146.
Coolidge's forceps.

knowledge of the applied anatomy of the bronchial tree. The best practice of all is afforded by an adult patient wearing a tracheotomy tube if the physician is fortunate enough to find such a patient who is willing to make capital of his infirmity.

If the physician who undertakes bronchoscopy or esophagoscopy is mechanical, and, in addition, has or will acquire an elementary knowledge of applied electricity, many difficulties in his new work will be easily overcome. Jackson is fond of saying, and saying it in his forcible way, that the extraction of foreign bodies is purely a matter of mechanical skill. Inborn skill, however, can be offset and sometimes surpassed by the skill which comes from willingness to learn and at-

tention to detail. And the details of instruments and instrumentation in bronchoscopy are many. The physician who is not willing to deal with these petty details is happier out of this kind of work. The moral of this little preachment is—learn your instruments, how they are made, how they should work, and how they are to be kept in order. "Gridley, you may fire when ready." You must be Gridley.

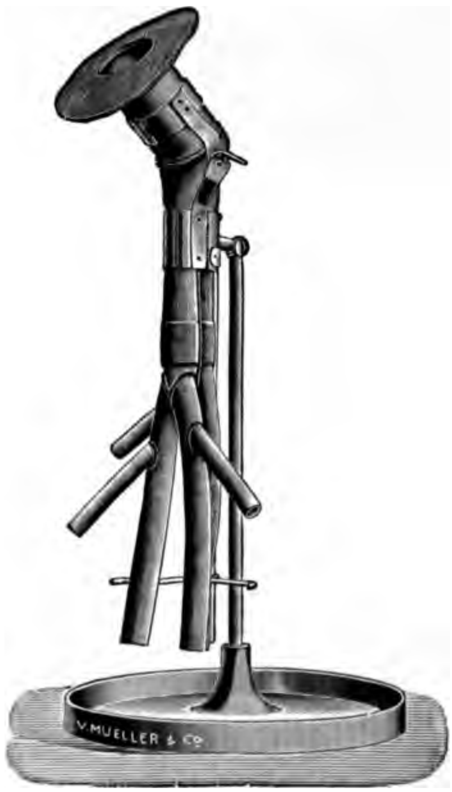


Fig. 147.
Killian's manikin for practicing bronchoscopy and esophagoscopy.

Direct Laryngoscopy for Diseased Conditions.

Malignant Disease.—Malignant disease often calls for the direct examination of the larynx in order to obtain a clear view of the growth, and especially to secure the removal of a satisfactory specimen. By the use of a good punch forceps (Fig. 145) this can be taken from the most favorable place, that is, from the margin of the growth so that the diseased and healthy tissue appear side by side. In small growths direct laryngoscopy and direct instrumentation should not be depended upon for a cure—the larynx should be opened from the outside; but in

advanced and inoperable malignant disease palliative procedures like the removal of obstructing masses are justifiable and are easily executed. (Figs. 148-150.)

Non-Malignant Disease of the Larynx.—Benign neoplasms of the larynx offer a wide field for the employment of direct laryngoscopy. Chief among these tumors are papillomata. In the experience of the writer the removal of papillomata under local anesthesia has not been successful. Even with the use of a general anesthetic and with the patient lying on his back the procedure is not always a calm one or

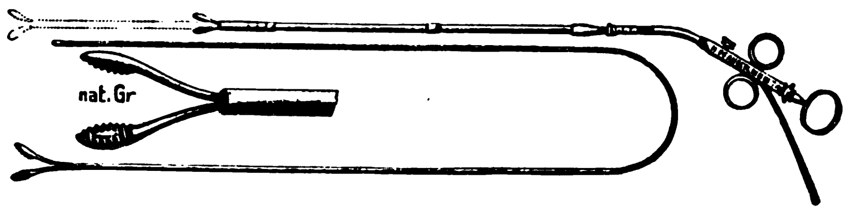


Fig. 148.
Brünings' elongating forceps.

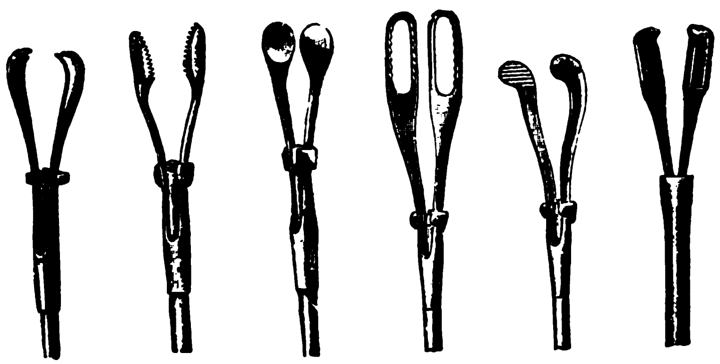


Fig. 149.
Tips for Brünings' forceps.

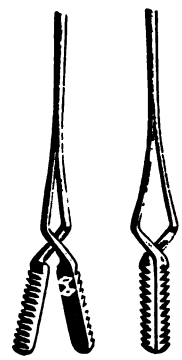


Fig. 150.
Expanding tip for Brünings' forceps.

fully satisfactory. Direct laryngoscopy, however, is by far the best method of conducting the removal of these luxuriant and recurring growths. The management of these cases advocated by Clark is the one followed by the author. The child is examined under ether by the direct method, and if there is an abundant growth tracheotomy is performed. Then the larynx is freed from papillomata by using appropriate instruments through the Jackson speculum or the open speculum. Where the vestibule of the larynx is nearly choked with the growth Mosher's spiral wire forceps (Fig. 151) will quickly remove a large amount and allow the remaining masses to be dealt with leisurely

and with the same instrument. The spiral wire forceps comes up with papillomata between the various wires like a fish net filled with fish. It is important in removing papillomata to wound the normal mucous membrane as little as possible because each abrasion is almost sure to have the growth transplanted upon it. When the papilloma is placed well forward on the cord or in the anterior commissure it

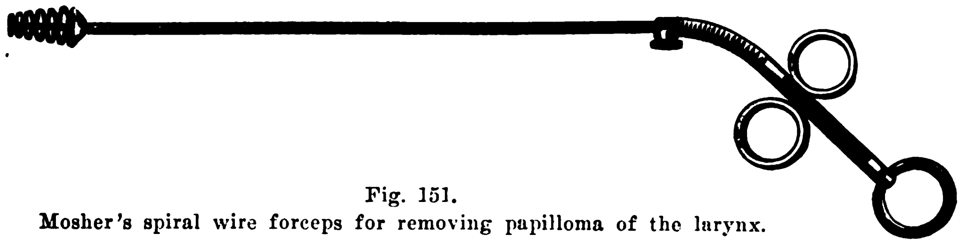


Fig. 151.
Mosher's spiral wire forceps for removing papilloma of the larynx.

is often very hard to expose even under general anesthesia. In such cases the triangular guillotine tube is useful for securing it. (Fig. 152.)

It has been the experience of Clark that after a child has worn the tracheotomy tube a year or more the papillomata shrink markedly and in time disappear. At appropriate intervals the child is etherized

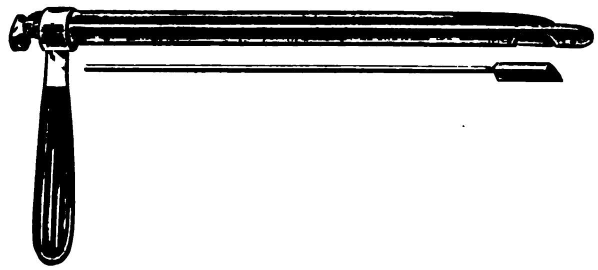


Fig. 152.
Mosher's triangular fenestrated tube. Used for the removal of pedunculated growths from the vocal cords. It is especially useful when the growth springs from the anterior commissure. In use the growth falls through the window of the tube and is cut off by forcing home the plunger which has a cutting edge and acts as a guillotine.

again and the remaining growths thinned out or eradicated. Some operators like Jackson do not practice tracheotomy in cases of papillomata but follow the growths through the cords into the trachea even without the safeguard of this procedure. An emergency tracheotomy, however, may be called for at any moment. This operation can be taken out of the emergency class and performed at the leisure of the operator if the patient is given air by intubing the larynx and trachea with a small bronchoscope. The author has made for this purpose the small instrument shown in Fig. 153 which he carries with his trache-

otomy set. It is small enough to pass into any larynx and long enough to go well down the trachea. It is fitted with a plunger so that very little exposure of the larynx is necessary for its quick introduction. There are breathing holes on the sides near the lower end. To have this simple instrument always at hand is a great comfort. It can be used with adults as well as with children.

Harris has lately reported the disappearance of a papilloma under radium.

Other benign neoplasms occur, and these, just as papillomata, are best dealt with by direct laryngoscopy. Among these are fibromata, lipomata, cysts and edematous polypi. Singers' nodes might be treated by this method should removal be advisable.

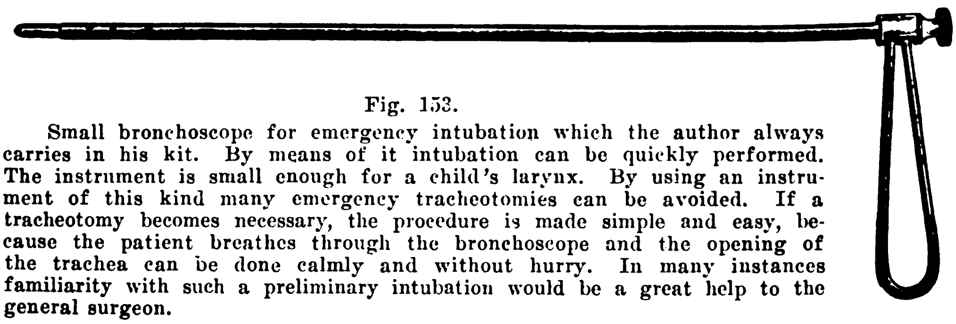


Fig. 153.
Small bronchoscope for emergency intubation which the author always carries in his kit. By means of it intubation can be quickly performed. The instrument is small enough for a child's larynx. By using an instrument of this kind many emergency tracheotomies can be avoided. If a tracheotomy becomes necessary, the procedure is made simple and easy, because the patient breathes through the bronchoscope and the opening of the trachea can be done calmly and without hurry. In many instances familiarity with such a preliminary intubation would be a great help to the general surgeon.

Tuberculosis of the Larynx.—When tuberculosis of the larynx calls for surgical treatment direct operating is most satisfactory.

Inflammatory Diseases.—In infections of the pharynx accompanied by edema or abscess the patient can be relieved by direct laryngoscopy and direct treatment and many a tracheotomy averted.

Malformations of the Larynx, Congenital and Acquired.—Congenital webs of the larynx are easy to make out and to treat by the direct method. An appropriate speculum and a long laryngeal knife are the only instruments usually needed.

After diphtheria, especially when it has been necessary to intube often, the cords may glue together for a certain part of their length. Generally the anterior third or two-thirds of the inner surfaces of the cords adhere. Such cases can be managed by prolonged intubation with large tubes of the Rodgers pattern. The cords must be first separated. This is done either with an Otis urethrotome or with the laryngeal knife. Then the aperture of the glottis and the region below, for the subglottic portion of the larynx is narrowed also, is stretched with the dilating mechanism of the urethrotome or better with a dilator constructed on the pattern of Kollman. As the Rodgers tube is conical and tends to slip out of the larynx it is retained by a clasp inserted

and worn through a permanent tracheotomy wound. For dilating the cavity of the larynx male urethral sounds may be passed through the tracheotomy wound upward into the larynx. Naturally the operative procedures are carried out by direct laryngoscopy. The insertion of the tube is most conveniently performed by direct intubation. In this country Wilson was the first to bring direct intubation before the profession. The author has devised a set of instruments for handling the tubes. The author also has used direct inspection a few times for the detection of laryngeal diphtheria, the removal of loose membrane and immediate intubation. Direct inspection generally makes the waiting for the microscopic report of a culture unnecessary. It is a great satisfaction to look down and to see the membrane and to take the case out of the emergency class then and there by intubation.

Retrograde Laryngoscopy.

Retrograde laryngoscopy is the name given to the examination of the larynx from below by means of a tracheoscope introduced through a tracheotomy wound. This method may give valuable information. The tracheoscope should be 5 mm. in diameter and 14 cm. long for a child, and 8 mm. wide and 20 cm. in length for an adult. (Jackson.)

Tracheobronchoscopy in Diseases of the Trachea and Bronchi.

Diseases of the trachea and the bronchi which call for bronchoscopy are divided into stenotic and non-stenotic.

Since the advent of bronchoscopy many cases considered as nervous cough have been found on examination by tracheobronchoscopy to be due to visible and curable lesions. Bronchoscopy was given its first great impetus when it was proved that it is possible to remove by its aid foreign bodies lodged in the trachea and bronchi. This field has been well exploited. In this country at least, but little work has been done with it in the various diseases which can be disclosed and treated by it. In the near future there should be a great advance in this line. For the fullest knowledge that we have on this subject the reader is referred to the book of Von Schroetter. Ulcerations near the bifurcation of the trachea which were causing chronic cough have been found repeatedly and cured by applications.

Chronic catarrhal inflammation of the trachea which does not yield to the usual forms of treatment justifies direct examination and treatment.

As a surgical feat which as yet has not been duplicated many times, but which may at any moment become a common procedure, the finding of pus near the periphery of the lung may be mentioned. Abscess of the lung due to a foreign body can be localized by the bronchoscope

and if the foreign body cannot be secured through the tube, the tube, or a probe passed through it can be used as a guide to the surgeon cutting from the outside.

Stenosis of the Trachea.—Neighboring organs not infrequently press upon the trachea and cause its partial occlusion. The thyroid gland is a frequent offender. As a rule it presses backward and since one lobe is generally more enlarged than the other the resulting narrowing of the trachea occurs in the anteroposterior direction and somewhat laterally. When the retrotracheal portion of the gland as well as the anterior part enlarges the trachea becomes a narrow oval slit, the "scabbard" trachea.

It has been denied that enlargement of the thymus could produce difficulty in breathing, the so-called thymic asthma. Jackson reports a striking case in which the condition was present. When the case was seen it demanded an immediate tracheotomy. This did not relieve the dyspnea. The passage of the tracheoscope showed that the trachea below the incision was flattened almost to complete closure from before backward, but the insertion of a long tracheotomy tube finally relieved this dyspnea and then the gland was removed, the case resulting in a cure. Tubercular glands, especially those at the bifurcation of the trachea, malignant disease of the esophagus or of the mediastinum, and aneurism often narrow the lumen of the trachea or of the primary bronchi. The diagnosis of these conditions may be confirmed or established by bronchoscopy.

Jackson gives the following table of diseases of the walls of the trachea and the bronchi which cause stenosis:

1. Malignant neoplasms.
2. Benign neoplasms.
3. Specific inflammations.
   - (a) Syphilis.
   - (b) Tuberculosis.
   - (c) Glanders.
   - (d) Typhoid fever.
   - (e) Diphtheria.
4. Inflammations.
   - (a) "Catarrhal."
   - (b) Irritative.
   - (c) Traumatic.
   - (d) Operative.
   - (e) Post-operative.
5. Post-inflammatory conditions as cicatrices and adhesions.
6. Vasomotor disturbances, angioneurotic edema.

Benign neoplasms are not frequent but when they are present they are well adapted for removal through the bronchoscope. In asthma sensitive areas have been found in the trachea and bronchi and applications made to them gave relief. Syphilis is the most frequent cause of stenosis. Next come the narrowings caused by the healed ulcers of diphtheria or of typhoid fever. Stricture of the bronchi from similar causes is occasionally seen.

Treatment.—The treatment of stricture of the larynx by prolonged intubation has been described. Strictures of the cervical portion of the trachea associated with loss of the cartilaginous rings are probably best treated by plastic surgery which aims at holding the trachea open by the transplantation of some rigid material. The success of the transplantation of cartilage for the correction of nasal deformity may open up a method of dealing with these cases of tracheal stenosis combined with loss of cartilage.

The treatment of low seated strictures of the trachea and of strictures of the bronchi is carried on along the same general lines as those employed for the treatment of strictures higher up, that is, the stricture is first dilated and then held open by intubation. Such strictures call for treatment because when they are small they interfere with breathing and expose the lungs to infection from the retention of infected secretions. Von Schroetter, who has carried on extensive investigations in these cases, first dilates the stricture with a sponge tent and then inserts a metallic tube so made that it is readily retained. It would seem that a mechanical dilator would accomplish the dilatation more speedily than the tent.

THE REMOVAL OF FOREIGN BODIES FROM THE LARYNX, TRACHEA AND THE BRONCHI.

Foreign Bodies in the Larynx.

Foreign bodies lodged in the larynx in most cases are either coughed up after the initial spasm of dyspnea caused by them or drop into the trachea or the bronchi. Occasionally the foreign body is loosened by the coughing and strangling and enters the esophagus and is swallowed. Sometimes the foreign body becomes impacted in the larynx and if it is large enough it speedily suffocates the patient. Now and then the foreign body may be small enough like a piece of egg shell to remain in the larynx, or it may be of the right shape like a button or a coin to lodge in the ventricles. Examples of cases of both kinds are found in the literature. When such cases present themselves direct examination combined with the use of appropriate instruments is the best method of removing the offending foreign body.

The Removal of Foreign Bodies from the Trachea and the Bronchi.

Until the advent of tracheoscopy and bronchoscopy the removal of a foreign body from the trachea was accomplished by performing tracheotomy. When a loose body like a seed was playing up and down the trachea seeking to escape it was often blown violently out of the wound by the first spasmodic expiration caused by entering the trachea. Such an outcome was dramatic and satisfactory. If, however, the foreign body was not free in the trachea but was impacted or was of a different nature from a seed, the old practice was to introduce forceps blindly and to fish for it. Many successful extractions have been performed in this manner. Many times, however, and the records are woefully incomplete as to how many times, the attempt at blind extraction has failed and has caused the death of the patient.

It was a natural and great advance in the treatment of these cases when, instead of the blind groping after foreign bodies in the trachea, the physician began to work by sight. Coolidge was the first to do this in America, in 1899. By using a female urethroscope he located and removed a piece of a tracheotomy tube which had become detached and had fallen into the trachea. Killian was the first to demonstrate the feasibility of removing a foreign body from the bronchus by means of a tube passed between the vocal cords. Killian devised and first practiced upper bronchoscopy, later he developed lower bronchoscopy. Einhorn in 1902 devised an esophagoscope having an auxiliary tube in the wall of the main tube. In the secondary tube a light carrier was inserted through which two wires ran to a small electric lamp on the end of the carrier. Two years later Jackson used the mechanism of Einhorn on the Killian tubes and added a second auxiliary tube for drainage purposes. Later the same investigator lengthened the bronchoscope and used it for exploring the stomach. He demonstrated the feasibility of introducing a straight tube into the stomach and taught the medical profession through his brilliant cases the value of the procedure.

The Choice of the Upper or the Lower Route.—Experience has proved that lower bronchoscopy is safer and easier than upper bronchoscopy. It is by all odds the safer procedure for the beginner. In infants and children under three years of age it is the operation of choice. Even with older children up to the age of seven or eight, if there is a loose foreign body which by its violent excursions up and down the trachea has caused trauma to the lower part of the larynx, or if the form of the foreign body is such that it is impacted, for example, a bean or a pin, lower bronchoscopy is surer and safer. If the

operator is skilled, upper bronchoscopy may be tried with children over three years old. Instances of success by this method are multiplying. Unless the procedure is soon successful, however, it should be abandoned for the lower route. It is not so much the increased length of tubes required for upper bronchoscopy, which makes it less advisable in many cases than lower bronchoscopy—because the self-lighted tube carries its light at the end and increase of length is not a serious factor—as it is the reaction of the larynx to the manipulations and the danger of cardiac arrest. (Crile.) The latter danger can be obviated or minimized by the use of atropin. Killian has collected nineteen cases in which after upper bronchoscopy an emergency tracheotomy was required. The gist of the matter seems to be that in the performance of upper bronchoscopy, a tracheotomy may at any moment be called for. Even after the successful outcome of the procedure the same holds true. With infants and young children lower bronchoscopy is preferable. In a child of any age it is not good practice to persist in upper bronchoscopy unless it is soon successful.

Indications.—Tracheobronchoscopy is called for in any case in which the presence of a foreign body is suspected. The dangers of the procedure are so slight that even when the presence of the foreign body is not sure an exploratory bronchoscopy is indicated. This is especially true in the case of children. The only contraindication to bronchoscopy is the presence of serious organic or systemic disease.

Dangers.—The chief danger in bronchoscopy occurs in the use of the upper route. This danger, as has just been pointed out, arises from edema of the larynx or from reflex cardiac arrest. Ingals has reported two cases of death, one three, and one six hours after the successful removal of a foreign body. These unexplained cases may have been due wholly or in part to the second of the dangers just mentioned. Apart from these two dangers the most common one is septic pneumonia, from the trauma occurring during the manipulations of extraction. Another danger and one which can be easily avoided is that of delaying the performance of tracheotomy when the patient begins to show signs which call for it.

The Danger from Leaving the Foreign Body Alone.—The dangers to which the patient is exposed by leaving a foreign body in place are vastly greater than the danger to which he is exposed by the performance of bronchoscopy at the hands of a man practiced in the art. The great danger incurred by a patient with a foreign body in the lungs is pneumonia, or abscess and gangrene of the lung. In most instances either complication is fatal. There are many cases reported in the literature of foreign bodies which have remained in the lungs a long

time whose presence was known or unknown, and which have been finally coughed out. But, judging even from the incomplete literature of the cases of the opposite nature, it is found that such fortunate terminations are rare. Should the patient escape septic pneumonia and the foreign body remain in the lungs, he is exposed to tubercular infection later. Killian is authority for the statement that such cases not infrequently terminate in this manner. It should be said in fairness, however, that sometimes the lungs will tolerate a foreign body for a long time. The author has in mind a case in which Coolidge removed a wire nail which had been in the right lung of the son of a physician for seven years. The symptoms were only an occasional cough. Another case occurs to the writer. This patient was a nurse. For five years now and without any discomfort she has had a metal clasp pin in her lung. The attempt to remove this pin was made on two or more occasions, once by Killian and once by Jackson.

The degree of danger which accompanies the removal of a foreign body naturally varies with its nature, shape and size, its location and the condition of the patient. Rounded objects are liable to fit a bronchus tightly and to shut off air to the portion of lung supplied by it. Therefore they are most liable to cause gangrene and abscess. A pointed object like a pin or a nail allows air to pass but it produces trauma by its excursions in the respiratory blast or produces erosion by lying long in one position. Either condition leads to infection.

Inorganic substances macerate and decay. When this happens they may be coughed out unless they have produced a fatal pneumonia before this take place. Seeds if uncooked do not macerate but swell on absorbing moisture and become firmly fixed in position. Peanuts, in this country at least, have proved to be very fatal foreign bodies to lodge in the lungs. The attempt at removal often crushes them and scatters the fragments deep in the tertiary bronchi.

Roe collected 1,417 cases of foreign body in the air passages. In 470 extraction was not attempted, and over 400 died, that is, the mortality was 27 per cent. This is to be compared with 94 cases of upper and lower bronchoscopy reported by Jackson in which the mortality was 3.2 per cent. If a foreign body is to be coughed out this generally occurs in the first twenty-four hours. Jackson sums up the matter fairly when he says "we do full justice to our patients when we tell them that while a foreign body may be coughed up, the chances of this are remote and it is very dangerous to wait; and further, the difficulty of removal increases with each hour that the body is allowed to remain."

Results.—Out of 94 cases of bronchoscopy the foreign body was removed in **85 per cent.** (Jackson.)

Symptoms.—Cough is the most constant symptom of a foreign body in the air passages. As the foreign body passes the larynx the cough is paroxysmal. Later at every attempt of the air passages to expel the intruder the cough is again paroxysmal. Some minutes or hours may elapse between the seizures. After a time the cough becomes more constant.

Dyspnea is a very frequent symptom. It is usually inspiratory but it may occur on expiration. The dyspnea is worse during the fits of coughing and at such times the patient may become unconscious. It should be borne in mind that a foreign body in the esophagus may, by pushing forward the soft trachea of a child, produce dyspnea.

The temperature is usually elevated. This might be taken as evidence in the doubtful cases against the presence of a foreign body. In late cases in which pneumonia has set in naturally the temperature is elevated.

Chills occur when an abscess has been produced about the foreign body.

Hemoptysis is not present as a rule. It is associated with the aspiration of sharp substances.

Pain is often present but it is generally poorly localized.

Diagnosis—The fluoroscope is not reliable in locating a foreign body unless it is very dense. An X-ray plate should be taken in all cases and interpreted by an expert. The physician who is not accustomed to reading plates taken of the lungs is very liable to mistake spots of calcification along the main branches of the bronchi for foreign bodies. Unless there is marked dyspnea it should be the routine to obtain a radiograph.

Metallic substances with the exception of aluminum show well in the plate. So do pebbles and objects of glass. Bones unless they come in front of another bone like a vertebra also show well. Fish bones come out poorly in the plate. Vegetable substances with the exception of some kinds of wood, do not cast much of a shadow. The same is true of peanuts and chestnuts without their shells. It is difficult to obtain a satisfactory X-ray of a young child unless it is etherized. Only in the case of a metallic foreign body when the plate shows nothing is it safe to permit the patient to go without an examination. Intermittent cough and dyspnea not to be explained in any other way and not associated with fever is almost diagnostic of the presence of a foreign body.

The Physical Signs.—The physical signs are of value in determining the presence of a foreign body in the air passages if they are elicited and interpreted by a physician who possesses a good and sufficient technic in auscultation and percussion. The physical signs are relied

upon most in those cases in which a positive X-ray cannot be secured. The following paragraphs which bear upon the physical signs and their meaning are abstracted from Jackson for whom they were written by Boyce.

In the examination a distinction must be made between the signs due to the foreign body and those which are due to inflammatory conditions which soon supervene.

A foreign body which is obstructing a bronchus may lead to atelectasis of the lung, If so, the usual signs are present. This occurrence, however, is not as frequent as is generally supposed. The most common finding is a marked local diminution of the respiratory murmur with preservation or accentuation of the normal resonance. This may be called the typical condition. When a foreign body partially obstructs a bronchus it may give rise to a peculiar dry râle, which is easily differentiated from that given by inflammatory or tubercular thickenings of the mucous membrance. These dry râles are limited to a definite area and occur for hours at a time.

Bronchitis is the commonest inflammatory condition following the inhalation of a foreign body. The secretions from this are soon diffused through the lungs and give the signs of a diffuse bronchitis. Diffuse bronchitis coming on suddenly, and especially if it is accompanied by bloody expectoration, is a most unusual condition and should raise the suspicion of the presence of a foreign body. The expectoration in foreign body cases is usually bloody and tends to become abundant, purulent and fetid. In such instances only the history and a careful examination of the sputum will rule out tuberculosis. If a localized abscess is present or lobar pneumonia, the signs of these conditions are the same as when they are not associated with a foreign body. In one case plural effusion resulted from the presence of a foreign body and the patient was twice tapped. (Ingals.)

Tuberculosis "without bacilli in the sputum," particularly if the disease is located near the base of the right lung, unilateral or unilobular bronchitis, and especially if hemorrhagic or fetid, atelectasis, abscess or gangrene, not otherwise explainable, should raise the suspicion of the presence of a foreign body in the air passages.

The **Location** of foreign bodies varies with the size and shape of the objects. Bodies of some size usually lodge at the bifurcation of the trachea or enter the right main bronchus. Pins often lodge at the bifurcation, one-half the pin being in the trachea and the other half lying in a primary bronchus. (Fig. 154.) Pins and nails, however, not infrequently fall into the smaller bronchi. In the experience of the author pins and nails frequently lodge in the inner branch of the bron-

chus to the inferior lobe of the right lung. Safety pins, if they are open, do not get beyond the trachea.

The Technic of Removing Foreign Bodies.—The first thing to accomplish is to bring the foreign body into view. The manipulations of the bronchoscope which are necessary to accomplish this have been described. After locating the foreign body and obtaining a good view the next important step is to use the proper instrument for seizing it. Many a case has resulted in disappointment owing to the fact that the physician went ahead without suitable instruments. Unless the case is

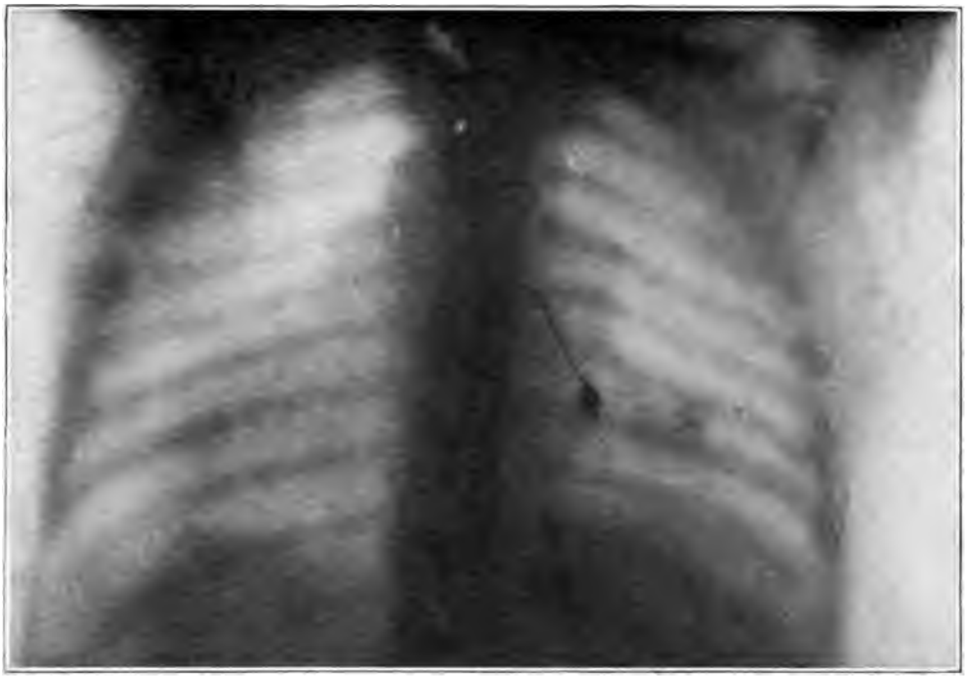


Fig. 154.
Pin with glass head in left main bronchus.

desperate, time should be taken to procure a forceps with a tip fitted to grasp the particular object dealt with. Beans and seeds call for a special tip. Pins may be extracted with the ordinary forceps, but in case the pin is impacted the pin cutter of Casselberry (Fig. 155) is essential. The usual bronchoscope has lateral openings in the lower third or half of its length so that air may not be shut off from the opposite lung during the examination. When dealing with a pin these openings should not come to the end of the tube, otherwise the pin may be caught in them. Open safety pins are best extracted with a closer (Brünings, Mosher, or Hubbard).

Soft, pliable substances like rubber call for a corkscrew-like instrument, as in the case reported by Richardson.

The greatest difficulty is found in the extraction of small bodies deeply placed in the bronchi. These are often macerated or imbedded in swollen mucosa. In working in the smaller bronchi and near the periphery of the lung the physician may find it necessary, on account of poor light or the diminutive fold, to pass the forceps beyond the tube and to close them blindly. Before this maneuver is executed a mark is placed on the shaft of the forceps to show the length of the tube.

Hooks of various shapes are useful to pass beyond a foreign body in order to prevent the forceps from pushing it down or to turn the foreign body so that the blades of the forceps can grasp it. The hook is passed flat until beyond the object and then turned and brought up.

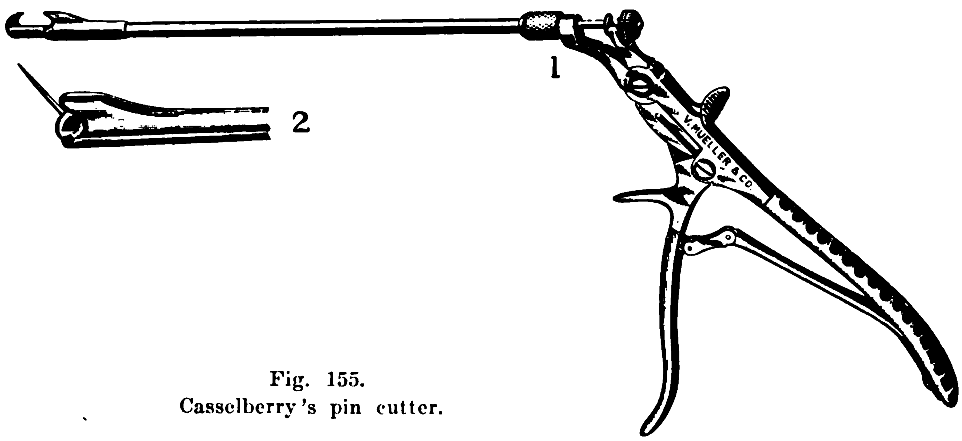


Fig. 155.
Casselberry's pin cutter.

Care is required not to catch the end of a fully curved hook in the opening of a bronchus.

In the case of hollow foreign bodies expanding forceps are of service. If the foreign body is lodged in a small cavity of the lung it may be necessary to dilate the opening into the cavity before the foreign body will come into view and permit extraction. Jackson has devised a dilator for this purpose.

Usually secretion is seen coming out of the bronchus in which the foreign body is lodged. Inflammatory swelling may indicate that the bronchus is invaded. A probe may be required to locate the foreign body. A suction apparatus is useful for removing fragments of seeds.

The After-Effects of the Removal of Foreign Bodies.—Unless edema of the larynx follows the manipulations required for the removal of a foreign body, the after-effects of bronchoscopy are slight. There may be some hoarseness for few days or a slight localized bronchitis. This is trivial and soon disappears.

ESOPHAGOSCOPY.

History.—Soon after the invention of the laryngoscope attempts were made to see the opening of the esophagus by pulling the cricoid cartilage forward with appropriate specula and then obtaining a view by means of a mirror held above in the pharynx. These experiments led to no practical results. In 1868 Bevan by means of a thin speculum, and two years later Waldenburg by means of a tubular speculum 14 cm. long succeeded in seeing the mouth of the esophagus. The latter also made an ocular diagnosis of a diverticulum.

Störk was the first man to pass a solid tube into the esophagus and to carry out direct esophagoscopy. Kussmaul (1868) explored the esophagus with a rigid tube and published his observations on the normal and the diseased esophagus, while his pupil Müller established the important clinical fact that the normal esophagus should admit a tube 13 mm. in diameter. The observations of Kussmaul, however, made little headway; later they were revived and popularized by Killian.

Störk and Kussmaul, then, were the two men who gave esophagoscopy its start. V. Mikulicz, a follower of Störk, was the next worker whose results proved to be fundamental. By the year 1881 he had carried out most important anatomic and physiologic researches and had noted common pathologic changes. For the next ten years no special advances in esophagoscopy were made. Since that time this method of investigation has been pursued with vigor. The advances have been along the line of improved technic and new instruments.

Anatomy.—The esophagus is a muscular tube which is the continuation of the pharynx. It starts from the back of the cricoid cartilage opposite the sixth cervical vertebra. At the mouth of the esophagus the lower border of the inferior constrictor muscle projects like a mound into its lumen and acts as a sphincter in a way similar to the action of the superior constrictor (Passavant's fold) in the upper part of the pharynx.

Structure.—The esophagus has an outer muscular coat of two layers and an inner glandular coat covered with pavement epithelium. A connective tissue layer joins the two chief layers. The thickness of the esophagus is 3 to 4 mm. The outer layer of the muscular part consists of longitudinal fibers and the inner layer of circular ones. (Fig. 156.) The anterior longitudinal fibers are attached to the back of the cricoid cartilage. The inner layer of circular muscular fibers is a continuation downward of the fibers of the inferior constrictor muscle. The upper end of the esophagus therefore is the lower end of the pharynx, so that voluntary muscular fibers predominate. From this

it happens that a foreign body arrested at the entrance of the esophagus is often thrown back into the pharynx and into the mouth.

Lymphatics.—The lymphatics of the esophagus enter both the mediastinal and the cervical glands so that in suspected cancer of the esophagus the glands at the root of the neck should be examined.

Position.—The esophagus has the vertebral column behind it and the trachea in front, and lies in the posterior mediastinum. At the fourth thoracic vertebra the arch of the aorta makes a transverse constriction in it and a vertebra lower down, the left main bronchus, at the fifth thoracic, makes an oblique line across its front surface. Below this point the heart lies on it like a weight. In the lower part, the right and left pneumogastric nerves lie on the sides of the esophagus, and back of the arch of the aorta the thoracic duct crosses from right to left behind it, on the front of the vertebral column. (Fig. 157.)

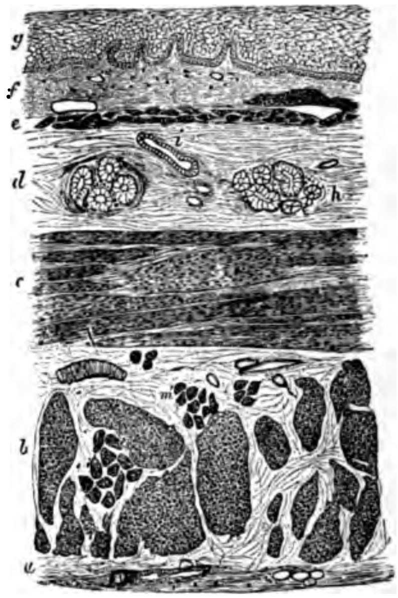


Fig. 156.

Section of the human esophagus (Moderately magnified). The section is transverse, and from near the middle of the gullet. (Quain's Anatomy—From a drawing by V. Horsley.)

a, fibrous covering; *b*, divided fibers of the longitudinal muscular coat; *c*, transverse muscular fibers; *d*, submucous or areolar layer; *e*, muscularis mucosæ; *f*, mucous membrane, with vessels and part of a lymphoid nodule; *g*, laminated epithelial lining; *h*, mucous gland; *i*, gland duct; *m*, striated muscular fibers cut across.

Direction.—The esophagus is placed for the most part a little to the left of the middle line. Midway in its course, at the fourth thoracic vertebra, it swings to the central line, back of the arch of the aorta, but at once goes to the left again and enters the stomach to the left and in front of the aorta, at the eleventh thoracic vertebra. This deviation from the center does not interfere with the passing of bougies or tubes except at the lower part where the esophagus pierces the diaphragm. (Figs. 158 and 159.)

The Diameter.—Only in the region of the mouth of the esophagus is the diameter relatively fixed. The esophagus is constricted at four points. Of these the upper and the lower ones are the most important. The upper one is caused by the projection backward of the cricoid cartilage, the lower by the encircling fibres of the diaphragm. The up-

per one hinders the introduction of the examining tube, the lower one obstructs the passage of the esophagoscope into the stomach. The first constriction is a transverse slit, slightly less than an inch wide; the second constriction is about of the same width. The long axis of this constriction is from right to left from behind forward.

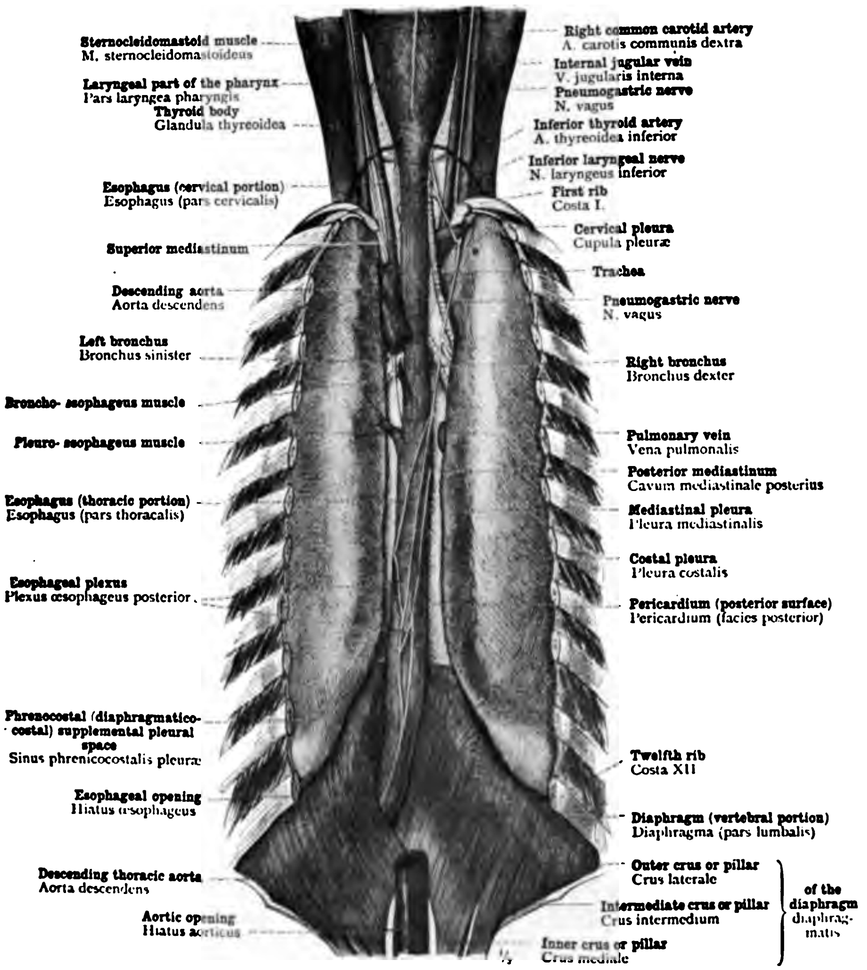


Fig. 157.
Showing the relations of the esophagus from behind. (From Toldt.)

The lumen of the esophagus at this point is subject to wide variations which depend upon the relaxation or the contraction of the diaphragm. In addition to these two important constrictions there are two others. Often they are not seen unless closely watched for, and they disappear

completely if large tubes are used. The first of these minor constrictions corresponds to the arch of the aorta, and is found at the level of the junction of the first and second pieces of the sternum and in front

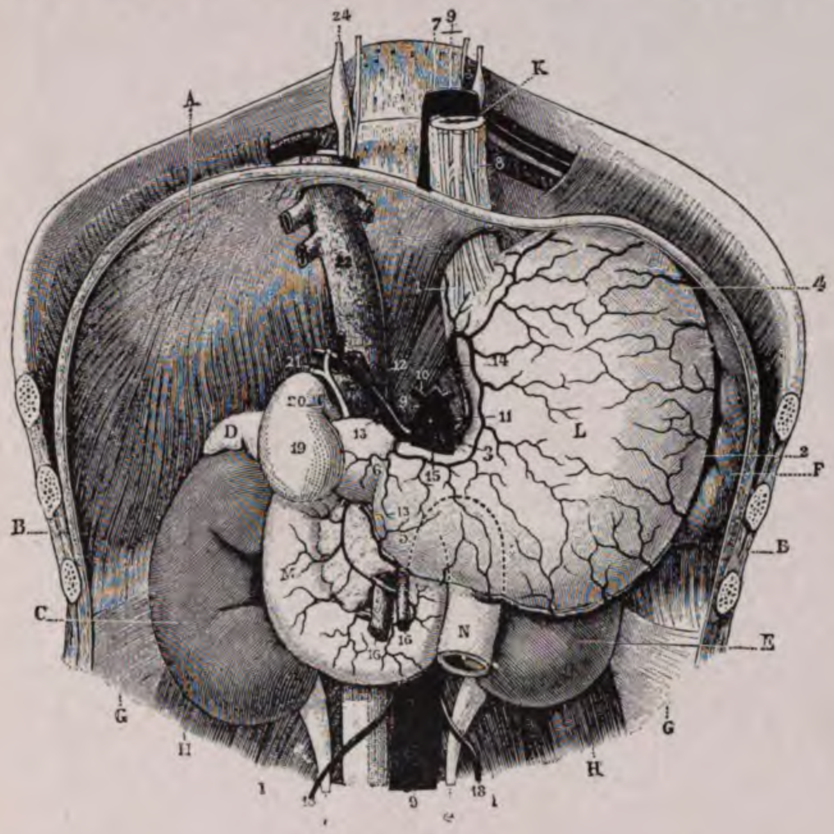


Fig. 158.

View of the stomach in situ after removal of the liver and the intestine (except the duodenum and commencement of jejunum). (Quain, after Testut.)

A, diaphragm; B, B′, thoracico-abdominal parietes; C, right kidney with c, its ureter; D, right suprarenal capsule; E, left kidney with e, its ureter; F, spleen; G, G′, aponeuroses of the transverse abdominal muscles; H, right quadratus lumborum muscle; H′, left ditto; I, right psoas magnus and parvus muscles; I′, left ditto; K, esophagus; L, stomach; M, duodenum; N, jejunum; the position of the duodeno-jejunal junction behind the stomach is indicated by dotted lines. 1, termination of esophagus; 2, great curvature of stomach; 3, small curvature; 4, fundus; 5, antrum pylori; 6, pyloric end; 7, right vagus nerve; 8, left ditto; 9, thoracic aorta; 9′, abdominal aorta; 10, inferior phrenic artery; 11, celiac axis; 12, hepatic artery; 13, right gastro-epiploic; 14, coronary artery; 15, splenic artery; 16, 16′, superior mesenteric artery and vein; 17, inferior mesenteric artery; 18, spermatic arteries; 19, gall bladder; 20, cystic duct; 21, hepatic duct; 22, inferior vena cava; 23, portal vein; 24, sympathetic cord.

of the fourth thoracic vertebra. The last constriction, which is the third from above downward, is made by the crossing of the left bron-

chus in front of the esophagus. It occurs at the level of the fifth thoracic vertebra.

The Length of the Esophagus.—In men the distance from the incisor teeth to the beginning of the esophagus is 15 cm. and in women 14 cm. The distance from the incisor teeth to the bifurcation of the aorta is 26 cm. in men, and 24 cm. in women. In men the length of the esophagus from the incisor teeth varies between 36 cm. and 59 cm., the normal average distance being 40 cm. In women the figures are a little smaller, 32 to 41, the average being 38 cm. When flexible bougies are used for measuring 1 to 3 cm. should be added to these measurements.

Distensibility.—All the constrictions of the esophagus are distensible. The upper constriction is less dilatable than the others, so that this is the one which gives the greatest trouble in esophagoscopy.

The normal esophageal wall, according to Jackson, will stretch 2 cm. without rupture. At times foreign bodies stretch it more than this.

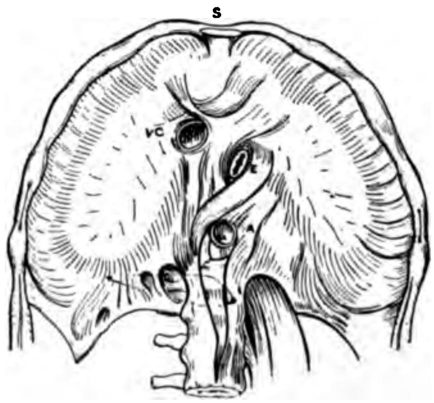


Fig. 159.
Under surface of the diaphragm. E, Hiatus esophagus. Note the direction of its axis. (After Jackson.)

In infants a tube of 7 mm. should pass readily and in the adult a tube which has a diameter of 14 mm. In infants a flexible bougie 8 mm. should pass and in adults one that measures 14 mm.

With light stretching the transverse diameter of the esophagus is 23 mm. at the cricoid cartilage and 17 mm. anteroposteriorly. The diameter of the esophagus as it goes through the diaphragm is 24 to 25 mm. Two stomach tubes can be passed side by side. Brünings states that the esophagus at its mouth can be dilated to 30 mm. without danger.

At the lower end of the esophagus V. Mikulicz in his operation for cardiospasm stretched the lumen to 7 cm. so that the hiatus had a circumference of 16 cm.

The distensibility of the esophagus is much greater in the living than in the dead. On the dead, when the esophagus is stretched transversely only it dilates to 40 mm., or one and one-half inches. The ordinary full-sized tooth plate is two and one-quarter inches (57 mm.) broad. A fifty-cent piece is one and one-eighth inches (30 mm.) wide. Since the transverse diameter of the esophagus is about one inch it would seem as if this coin should pass readily in an adult. The direction in which the esophagus will stretch the most is from side to side. For this reason oval tubes take up the slack in the esophagus along anatomic lines better than round ones.

The Subphrenic Portion of the Esophagus.—Beginning at the level of the bifurcation of the trachea the esophagus comes to the front and passes over the descending aorta and enters the abdomen through the hiatus or the opening in the diaphragm. This subphrenic part of the esophagus varies much in shape according as the stomach is empty or distended. In persons of spare build it has a lateral range of movement amounting to 10 or 15 cm. (Fig. 160.)

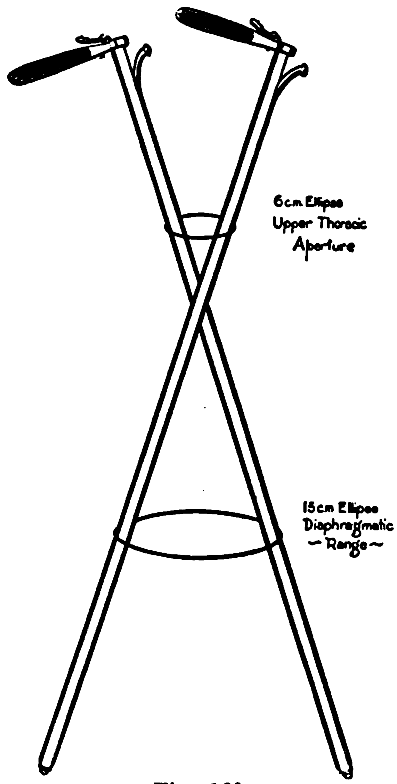


Fig. 160.
Schema showing the range of motion of the gastroscope at the mouth of the esophagus and at the hiatus of the diaphragm. (After Jackson.)

The Movements of the Esophagus.—The esophagus is never twice alike even in the same individual. At the level of the fourth thoracic vertebra (24 cm. from the teeth) the throbbing of the arch of the aorta can be seen if watched for and a little lower at the level of the seventh and eighth thoracic vertebra (30 cm. from the incisor teeth). The backward mounding of the heart and its beating are visible.

If a relatively small esophagoscope is used for the examination the esophagus opens with inspiration and partially closes with expiration. These changes occur chiefly in the thoracic portion, and are due to the negative intrathoracic pressure. If a large tube is used the esophagus stands wide open after the cricoid cartilage has been passed and the respiratory changes nearly disappear.

During swallowing peristaltic movements pass along the esopha-

gus from above downwards, while in vomiting the movements are reversed.

There is good evidence to support the assertion that there is a sphincter at the cardiac end of the esophagus, due to the presence of two layers of muscular fibres as described by Hyrtl. According to Jackson, the presence of this sphincter is not the chief agency through which the regurgitation of food is prevented. This observer maintains that the kinking of the esophagus below the opening of the diaphragm and the increase of this twist by distension of the stomach has much more to do with keeping the food in the stomach than the presence of the cardiac sphincter. From a few anatomic findings which have come to the notice of the author he is inclined to think that Jackson's position will be sustained.

Measurements of the Esophagus.—The following tables are compiled from Stark. They are of use for reference.

DIAMETERS OF THE ESOPHAGUS AT THE FOUR CONSTRICTIONS.

Constriction.	Diameter.	Vertebra.
Cricoid	Transverse 23 mm. (1 in.) Anteroposterior 17 mm. (¾ in.)	Sixth cervical.
Aortic	Transverse 24 mm. (1 in.) Anteroposterior 19 mm. (¾ in.)	Fourth thoracic.
Left bronchus	Transverse 23 mm. (1 in.) Anteroposterior 17 mm. (¾ in.)	Fifth thoracic.
Diaphragm	Transverse 23 mm. (1 in. +) Anteroposterior 23 mm. (1 in. —)	Tenth thoracic.

LENGTH OF THE ESOPHAGUS AT DIFFERENT AGES.

	Teeth to Cricoid.	To Bifurcation.	To Cardia.	Length of Whole Esophagus
Birth,	7 cm. (2¾ in.)	12 cm. (4¾ in.)	18 cm. (6¾ in.)	10 cm. (4 in.)
1 year,	10 cm. (4 in.)	14 cm. (5½ in.)	22 cm. (8¾ in.)	12 cm. (4¾ in.)
2 years,	10 cm. (4 in.)	15 cm. (6 in.)	23 cm. (9 in.)	13 cm. (5⅛ in.)
5 years,	10 cm. (4 in.)	17 cm. (6¾ in.)	26 cm. (10¼ in.)	16 cm. (6⅜ in.)
10 years,	10 cm. (4 in.)	18 cm. (7 in.)	28 cm. (11 in.)	18 cm. (7 in.)
15 years,	14 cm. (5½ in.)	23 cm. (9 in.)	33 cm. (13 in.)	19 cm. (7½ in.)
Adult,	15 cm. (6 in.)	26 cm. (10¼ in.)	40 cm. (15¾ in.)	25 cm. (10 in.)

For memorizing the length of the esophagus at different ages the following approximate figures are given: Birth, 7 inches; 5 years, 10 inches; 15 years, 13 inches; 25 years or adult, 16 inches. Add three inches for every five years. (Stark.)

DIAMETER OF TUBES FOR DIFFERENT AGES.

To 8 years	9 mm.
From 9 to 15 years	11 mm.
From 17 years	12 to 14 mm.
Adults	14 mm. (average.)

The esophagus begins 6 inches from the incisor teeth, back of the cricoid cartilage at the sixth cervical vertebra. It is 10 inches long, and goes through the diaphragm at the tenth thoracic vertebra, 16 inches from the teeth. It is crossed by the arch of the aorta back of the middle of the first piece of the sternum, 10 inches from the teeth. The measurements to be remembered in connection with it are, then, 6 and 10.

Contraindications to Esophagoscopy.—The only contraindications to the performance of esophagoscopy are acute inflammation as after the swallowing of corrosive fluids, and aneurism of the aorta. The chief danger in the passage of the esophagoscope is rupture of the esophagus. This almost always results in infection of the posterior mediastinum and death. Such an accident should be easily avoided by the selection of a tube of the proper size and by adhering always to the fundamental axiom of all esophageal examinations, namely, the examining tube must never be advanced unless the eye of the physician sees the open esophagus ahead through the tube. It is well, also, to remember that in old people the esophageal wall may be thin enough to rupture of itself so that in the elderly smaller tubes and greater care in using them are necessary. It has developed of late years that there is considerable shock from manipulations carried out in the esophagus. Indeed, working in the esophagus causes more shock than working in the trachea and bronchi. Relatively children do not bear esophageal examinations as well as adults. When a patient is poorly nourished, and especially if he is on the point of starvation from the presence of a stricture, it is better practice to open the stomach and feed the patient through a gastric fistula until his resistance has been restored before attempting any prolonged esophageal examination.

Anesthesia.—The esophagus may be examined under local or general anesthesia. In European clinics local anesthesia is employed for adults almost exclusively. Children are examined under ether or chloroform. In this country many examinations are carried out under general anesthesia. The author is very much prejudiced in favor of a general anesthetic. If the manipulations under cocain anesthesia are successful the operator gains his point, but if the examination is negative no conclusions can be drawn from it and the case remains in doubt. On the other hand, if the examination has been conducted under ether and the result is negative both the patient and the physician feel confidence in the finding. Under ether larger tubes can be used which means a better view and a larger field for the manipulations. In addition under such conditions the treatment called for by the case, for example the dilatation of a stricture, can be made more efficient.

Instruments.—In esophagoscopy all bridges must be crossed before

the operator gets to them. In other words the physician must be willing to supply himself at the beginning of his work in this line with a full set of general and special instruments. As everything depends upon light it is good economy to have two sets of tubes, one set being the self-lighted tubes of Einhorn-Jackson, and the other the extension tube of Brünings which is lighted by having the light projected through it from the electroscope. (Fig. 161.)

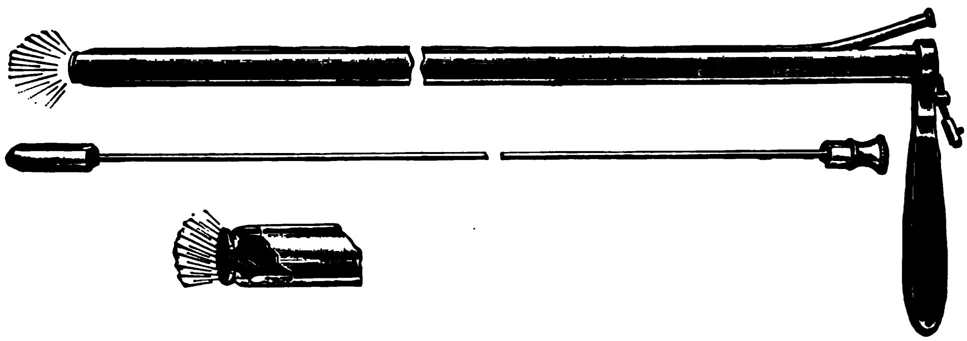


Fig. 161.
Jackson's esophagoscope. The drainage tube runs the whole length of the instrument.

The list recommended is as follows:

1. One 7 mm. Jackson tube.
2. One 14 mm. Jackson tube.
3. One adult tubular speculum (Jackson).
4. One tubular speculum, children's size (Jackson); or one adjustable speculum (Mosher).
5. One Brünings' or Kahler's electroscope.
6. One Brünings' extension esophagoscope, about 7 mm.
7. One Brünings' extension esophagoscope, 14 mm.
8. Nine Coolidge's cotton carriers. Three 25, three 35, and three 50 cm. long.
9. One grasping forceps with three shafts—25, 35, and 50 cm. long respectively (Coolidge or Jackson); or one extension forceps (Brünings) with three tips—claw toothed tip, tip for grasping seeds, and a punch tip.
10. One esophageal dilator (Brünings, Mosher).
11. One metal probe carrying three graduated olives (Bunt pattern).
12. One set elastic esophageal bougies from the smallest size to No. 40 (French). The series should be complete up to No. 20.
13. One Casselberry's pin cutter.
14. One Jackson's safety pin forceps; or one Mosher's safety pin closing tube.
15. One tooth plate cutter (Kahler or Mosher).
16. One metal staff having a perforated olive at the tip. A set of graduated olives and a flexible introducer (Mixter and Mosher).
17. One suction apparatus. Either a hand bulb, Jackson's secretion aspirator, or a suction apparatus run by electricity. When needed this last apparatus is a great luxury.

The author does most of his esophageal work under ether and prefers to use as large a tube as the esophagus under examination will take. Accordingly he uses a large oval tube of two lengths. (Fig. 162.)

The tube has a mandarin which projects from the end an inch and a half. The pointed end of the plunger readily finds the opening of the esophagus and pushes the cricoid cartilage forward and allows the tube to slip by. The tube has no secondary tube on the outside either for the light or for suction. The tube is therefore smooth. The introduction of the large tubes with secondary tubes on the side is dangerous because the tubes tend to cut. The author had one fatality due to this cause. Instead of the suction tube a short tube comes off from the main tube near its upper end. This is for the introduction of air. The tube is fitted with a metal plug which has a glass end. When this window plug is in place the esophagoscope becomes essentially airtight and the esophagus may be ballooned at will by closing the tube with the window plug and then forcing air through the

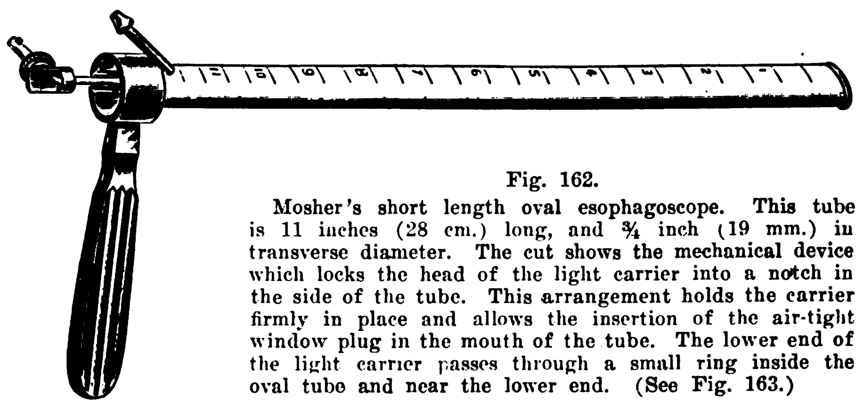


Fig. 162.
Mosher's short length oval esophagoscope. This tube is 11 inches (28 cm.) long, and ¾ inch (19 mm.) in transverse diameter. The cut shows the mechanical device which locks the head of the light carrier into a notch in the side of the tube. This arrangement holds the carrier firmly in place and allows the insertion of the air-tight window plug in the mouth of the tube. The lower end of the light carrier passes through a small ring inside the oval tube and near the lower end. (See Fig. 163.)

secondary tube. A stout foot bellows is used for this purpose. The light carrier runs inside of the main tube, and as it is not incased in a small tube of its own it runs freely at all times. (Figs. 162-167.) The secondary tube for the light carrier is bitten and dented continually so that the light enters it poorly. The light of the oval tube is incased in a hood. This protects it during insertion and while the tube is in use. The light once adjusted in its hood burns much longer than when it is exposed to the dangers of passing through the secondary tube. Each tube is fitted with a second or extra carrier so that the operator seldom has the annoyance of having to fit a new lamp during an examination.

The General Examination of the Patient.—A general physical examination of the patient should be made before esophagoscopy is attempted. Aneurism should be excluded and the condition of the heart ascertained. The patient's ability to swallow, the place where

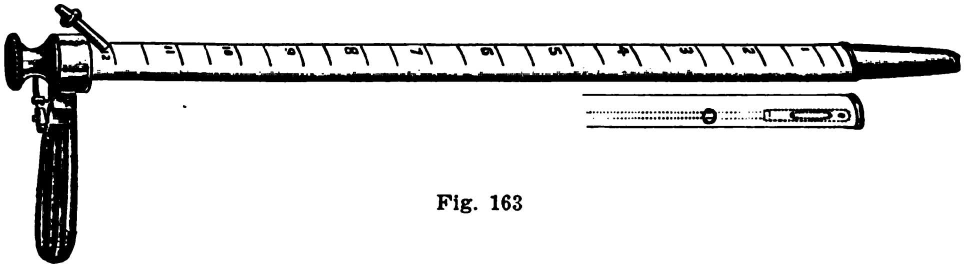


Fig. 163

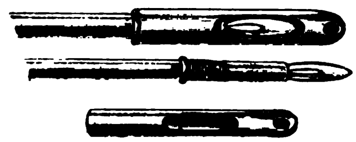


Fig 164

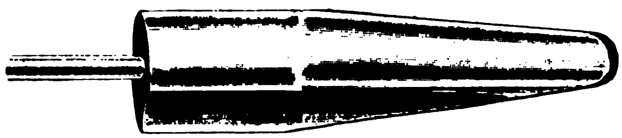


Fig. 165.

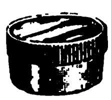


Fig. 166.

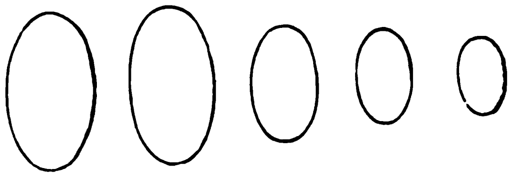


Fig. 167.

Fig. 163.—Mosher's esophagoscope (short length). This tube is made in two lengths—11 inches (28 cm.) and 17 inches (43 cm.)

The lower figure shows the method of holding the lower end of the light carrier in place by passing it through a small ring on the inside of the main tube.

Fig. 164.—Hood or cap which protects the lamp. This arrangement of the light carrier the author has found more satisfactory than the accessory channel on the outside of the tube. The outside channel makes a rib which on larger tubes tends to cut the soft tissue. The outside channel is constantly becoming dented so that the light carrier runs poorly and the contact of the lamp is disturbed. When the light carrier runs inside the tube and is protected by the hood there is much less trouble in keeping the light in good condition.

Fig. 165.—Long conical plunger for Mosher's oval esophagoscope. This plunger extends beyond the end of the tube 1½ in. This plunger readily enters the esophagus and pries the cricoid cartilage forward and allows the tube to follow after easily.

Fig. 166.—Window plug for making the esophagoscope air tight and ballooning the esophagus.

Fig. 167.—Different sizes of Mosher's oval esophagoscopes.

he locates his trouble, and all the details about regurgitation or vomiting are important to obtain. The condition of the teeth is observed and the presence of crowns or bridges noted and remembered. The examination of the mouth and pharynx should know the existence of ulcerations or scars and the laryngoscope will give the condition of the larynx. If disease is present in the larynx it is often a part of a similar process in the esophagus or a clew to it. An X-ray plate is indispensable before many examinations. The plate shows the location of metallic foreign bodies and pieces of bone and buttons; it shows enlargement of the arch of the aorta and enlargement of the mediastinal glands, and combined with the ingestion of bismuth it shows the position of strictures, the size and location of diverticula, and the size of the dilated esophagus.

The old practice of passing a bougie into the esophagus should be given up in most cases. If a foreign body is present the bougie may push it down or impact it or pass by and fail to locate it. If a carcinoma is present it will start bleeding and make the esophageal examination more difficult. Many patients have been killed by forcing a bougie through the carcinomatous esophageal wall. If the physician is dealing with a case of cicatricial stenosis of the esophagus or a pouch, the bougie is safe and may give valuable data. The information, however, is much better gained by the esophageal examination with the tube.

In speaking of the risks of esophagoscopy it was stated that the greatest danger was the liability of perforating the esophagus. This can happen before the examination, as well as during it. If, therefore, a case presents itself for examination and the patient has great pain on swallowing along the line of the sternum, if the respirations are increased, if fever is present, and there is emphysema of the skin, the physician should suspect that the esophagus has already been perforated and that an abscess is developing in the mediastinum. In such a case drainage of the abscess is indicated, not esophagoscopy.

The patient should be examined with an empty stomach and if possible with an empty esophagus.

The ease of esophagoscopy under local anesthesia depends upon the tolerance of the patient's pharynx. Brünings has a long, thin tongue depressor with which he tests the sensitiveness of the patient. The first introduction of the cotton swab in the preliminary application of cocain does just as well and soon settles the question as to whether or not the subject is an intolerable gagger. The experienced examiner always looks with anxiety at the patient's neck and teeth. If the upper jaw does not project and if the teeth are short, or better still, if there

are no upper teeth, if the neck is long and thin and the lower jaw well rounded at the angle and freely movable the chances for a favorable examination are good. When opposite conditions are present the examination is often difficult, sometimes impossible.

Technic of Esophagoscopy Under Cocain Anesthesia.—By means of an appropriate applicator, that of Sajous is very convenient, a ten per cent solution of cocain is applied to the base of the tongue and to the posterior pharyngeal wall. After an interval of a few minutes, under guidance of the laryngeal mirror, cocain is placed on the tip of the epiglottis and allowed to run into the larynx. After another interval of some minutes the swab is carried down on the posterior pharyngeal wall to the opening of the esophagus and applied at this point and to the region of the arytenoid cartilages. It is well to repeat this deep cocainization at least once. It takes from fifteen to twenty minutes to obtain a satisfactory cocainization.

Position of the Patient.—The patient can be examined either in the sitting position or on his back with the head over the end of the table and held by an assistant. The sitting position is best adapted to short examinations. It is easier for the patient especially if he is old or stout. Where it is essential to have the esophagus clean as in cases of spasm of the cardia with dilitation, stricture, or the presence of a foreign body, as well as with children or weak or sick patients, the prone position is preferable.

If the sitting position is adopted the patient sits on a low stool 25-30 cm. in height and an assistant stands behind him and holds the head. If the patient is examined on a table he may be placed on his back or on his side. Of the two lateral positions the left is the easier because the physician works with the right hand. If the teeth are missing on the right side of the upper jaw the right lateral position is preferable. If the incisor teeth have been lost the prone position is chosen. This position is selected also if the operator wishes to pass the esophagoscope into the stomach because in this position it is easier to bring the shaft of the esophagoscope to the right and to make the point enter the hiatus of the diaphragm and to traverse the subphrenic portion. In either the lateral or the dorsal positions the knees are drawn up slightly because the muscular relaxation caused by this makes the passage of the tube easier.

The Introduction of the Esophagoscope by Sight.—The ideal way of introducing the esophagoscope is to insert it under the guidance of the eye. The patient, anesthetized with cocain, is placed on a low stool, and an assistant stands behind him and holds his head. Care should be taken that the head is not placed too far back as exces-

sive backward bending interferes with the insertion of the instrument. The room is darkened and the upper part of the extension esophagoscope, if the Brünings tube is chosen, is warmed and smeared with vaseline and attached to the electroscope. The operator holds the upper lip of the patient out of the way with the thumb and forefinger of the left hand. The first part of the extension esophagoscope is really an elongated tubular speculum ending in a pointed lip. It is, therefore, introduced like the autoscope. That is, it is introduced into the mouth and steadied by the tip of the thumb of the operator's left hand, is carried back over the base of the tongue until the summit of the epiglottis is seen through the tube. At this point the handle of the gastroscope is raised and the lower end of the tube is passed over the epiglottis. The shaft of the tube is elevated until it lies snugly against the physician's forefinger which is guarding the incisor teeth or the gums if these teeth are missing. If the epiglottis is missed the point of the tube is almost certain to bring up against the posterior pharyngeal wall much to the discomfort of the patient. After the tip of the epiglottis is recognized and passed, the end of the tube is carried down until the arytenoid cartilages are seen. These are readily made out if the patient is asked to phonate. The point of the tube is now swung a little backward to clear the arytenoids and the tube is advanced a few centimeters to the opening of the esophagus. This appears as a transverse slit. The end of the tube is now brought forward a bit in order to open the esophagus. If this does not happen the patient is almost sure to swallow and when he does so, the tube slips into the esophagus. Sometimes the patient must be asked to swallow before the tube will drop in. In difficult introductions the point of the tube may be placed deep in the left pyriform sinus and then swung round to the median line. As it does this it pries the cricoid cartilage forward. Once past the cricoid cartilage the progress of the tube is easy. The tube is now carried down, advancing slowly, to its full length, the examiner all the while guiding the point by looking through the tube. The tube must never be advanced unless the esophagus ahead is open to receive it. When the tube has been advanced to its limit the second tube is inserted inside the first one and carried down by sight. When the Jackson tubular speculum is used for the introduction of the esophagoscope the steps are the same as for the first Brünings tube. After the mouth of the esophagus has been located and made to remain open a Jackson esophagoscope is carried through the speculum and into the esophagus. The speculum is then withdrawn.

The Introduction of the Esophagoscope by Means of a Flexible Mandrin or Bougie.—A beaked, partially open speculum is carried

down to the opening of the esophagus and a snugly fitting bougie is passed through it and carried into the esophagus. The speculum is withdrawn and an esophagoscope is passed over the bougie into the esophagus. This procedure, which often makes the introduction of the tube very easy, should never be used when it is the purpose of the examiner to determine the condition of the extreme upper end of the esophagus or when a foreign body is impacted in this locality. Another method of using the bougie as a guide is to pass a Jackson esophagoscope of the proper size below and behind the arytenoid cartilages and then into the opening of the esophagus. A bougie is then passed through the tube and finally the tube is pushed down over the bougie.

The Introduction of the Esophagoscope Under General Anesthesia. —The patient is prepared for ether in the usual way. He is given an injection of one one-hundredth of a grain of atropin and one-sixth of a grain of morphin. The atropin produces a nearly dry esophagus except in those instances in which the esophagus is dilated and filled with food or a pouch is present and acts as a reservoir. A suction apparatus is not usually necessary, but is always a great luxury. The author is using it more and more. If the operator works sitting, the table on which the patient is placed should be of the proper height to permit the surgeon to work at ease. If the operator prefers to stand the table should be placed on a platform large enough to hold not only the table but the stool for the assistant who holds the head and for the etherizer. The corner of the platform opposite the head of the operating table is cut out to allow standing room for the operator. During the examination should it become advisable to lower the head of the patient the operator is not forced to work on his knees. An assistant holds the patient's head over the end of the table. His left hand supports the patient's head and his left knee supports his hand while his foot rests upon a support of suitable height. The assistant should so grasp the head that he can transfer it at any moment to the physician, be ready to receive the head back and to hold it in the new position indicated by the surgeon. Thus the patient's head is continually passing from the hand of the assistant to that of the operator. It is vital that the head should not be extended too far backward. If this is done the cricoid cartilage is held tightly against the sixth cervical vertebra and will not move forward before the advancing tube without the application of great force. A rough introduction of the esophagoscope may cause sloughing of the posterior esophageal wall. This may have a disastrous outcome in a weak patient. The formation of the mouth of the esophagus calls for another word. It is bounded in front by the cartilaginous ring of the cricoid cartilage and behind by the body of the

sixth cervical vertebra. Only on the side where the pyriform sinuses lead into it are the walls composed of soft tissues. The natural channel for food into the esophagus is by way of the pyriform sinuses and experience has shown that the pyriform sinus is the natural and the easiest channel through which to pass the esophagoscope. If the tube chosen for the introduction into the esophagus will not pass, the operator should at once select a smaller tube until one is found which will enter without being forced. The tubes which are most useful according to Brünings are 10, 12 and 14 mm. Practically every patient will admit a tube of one size or another unless the body of the sixth cervical vertebra is enlarged, or the cervical vertebræ are diseased.

It is usually possible to pass the tube by sight and this method should be attempted first. Suppose the Jackson instruments are selected. The procedure of introducing the esophagoscope by sight is as follows: If the teeth are intact or if they consist chiefly of stumps those of the upper jaw are protected by inserting a thin aluminum tooth plate. If the gums are bare of teeth the use of the tooth plate is just as important for the later comfort of the patient. In a hard introduction, no matter which instrument is used, the tooth plate should be employed until the tube is well in the esophagus because notwithstanding assertions to the contrary, teeth may be nicked, broken or forced from their sockets. Patients do not readily forget such an occurrence. The teeth, then, have been protected with a tooth plate and the assistant holds the head bent backward moderately. The jaws are kept slightly apart by a gag placed in the left corner of the mouth. The tongue is made to lie naturally and the end of the tubular speculum is carried along the central furrow of the tongue, and is pushed forward and downward until the tip of the epiglottis is recognized. The tip of the epiglottis and then the body of the epiglottis are picked up by the end of the speculum in turn and drawn forward until the arytenoids appear. These in turn are passed by inserting the point of the speculum behind them and forcing them forward, and the speculum is carried still further down. All the time the operator is making traction forward. When the proper depth has been reached the back of the cricoid cartilage is encountered and this like the structures above is pushed forward. At this point the mouth of the esophagus opens and the operator looks into the lumen of the esophagus for a considerable distance. In favorable cases, especially in infants and children, he can see down the esophagus almost to the inner end of the clavicles. With the cricoid cartilage drawn forward and the mouth of the esophagus gaping it is a simple matter to pass the esophagoscope through the tubular speculum into the esophagus, to remove the slide and to withdraw the speculum. In-

troduction by sight is the ideal method, because in this procedure there are no blind points. It is not necessary to describe the introduction by sight of the Brünings extension esophagoscope. The first part of his double tube takes the place of the Jackson tubular speculum and is used in the same manner. After the esophagoscope has been inserted, if the purpose of the examination is to explore the whole length of the esophagus, pathologic conditions permitting, the tube is swung to the corner of the mouth on the right. If any teeth are fortunately missing on this side the barrel of the esophagoscope is made to lie in the tooth gap. Should it happen that the missing teeth are on the left side and the introduction difficult it is well to shift the tube to the left corner of the mouth.

The Use of the Adjustable Speculum for the Introduction of the Esophagoscope.—The author has for some years worked with his open and adjustable speculum for the examination of the upper end of the esophagus and for the introduction of the esophagoscope. The speculum is an adjustable tubular speculum with the right side cut away. Owing to this fact all the landmarks of the pharynx and larynx can be seen ahead of the speculum and in their proper perspective. There is a large lateral excursion for the eye, which reduces the eye strain, and makes the introduction of the tube easier, thus giving a greater play for instrumentation about the arytenoids, in the pyriform sinus and in the upper part of the esophagus. The speculum is introduced in the same manner as the tubular speculum of Jackson. Should the purpose of the examination be to examine the esophagus below the clavicles, the cricoid cartilage is pulled forward, the upper portion of the esophagus is exposed, and then the esophagoscope is passed by sight through the speculum into the esophagus and the speculum taken out. The tooth plate, if it has been used, is retained or not at the discretion of the examiner.

Passing the Jackson Esophagoscope by Sight.—The Jackson esophagoscope can often be passed by sight, especially if a tube of moderate size is selected. The manipulations are the same as in the introduction of the tubular speculum. The field given by the esophagoscope is, of course, somewhat smaller than that which is given by the tubular speculum. This difference in an easy examination amounts to nothing. When the esophagoscope has been passed by sight to the arytenoid cartilages the point is swung to the right into the pyriform sinus and entered deeply at this point. When it reaches bottom, so to speak, the point is swung back to the middle line. As this occurs the tube forces the cricoid cartilage forward and slips into the mouth of the esophagus.

Passing the Oval Tube by Sight.—As the author has done prac-

tically all his work upon the esophagus under ether anesthesia, he prefers to use for the esophageal examination as large a tube as the esophagus can be made to take. Oval tubes take up the slack of the esophagus along anatomic lines better than round ones. For this reason the writer employs large oval tubes. These are made in two lengths—an eleven-inch tube and an eighteen-inch tube. So many of the pathologic conditions of the esophagus are found in the upper part and the eye strain is so vastly increased by looking through a long tube that it is economy of eyesight to have tubes of two lengths. The short oval tube is selected and passed by sight to the right pyriform sinus. At this point the transverse axis of the tube is made to lie anteriorly by rotating the tube to the right. The tube will then sink further into the sinus. When the point of the tube is as far in the pyriform sinus as it will go without being forced, the tube is rotated back to its original position with the long axis again transverse. As this manipulation is carried out the left edge of the oval tube insinuates itself behind the body of the cricoid cartilage, thus pushing it forward, and the tube enters the esophagus. All these manipulations are seen by the examiner as he guides them through the tube. The field which the large tube gives is so superior to that afforded by a round and smaller tube that every legitimate effort should be made to introduce as large a tube into the esophagus as will pass the cricoid cartilage. Even a large oval tube seems too small for the calibre of the esophagus once the cricoid cartilage has been passed. The examiner gets this impression even in the normal adult esophagus, to say nothing of the dilated esophagus of cardiospasm.

The Passing of the Esophagoscope by Aid of a Mandrin or a Flexible Bougie.—In the early days of the esophagoscope it was almost always introduced by means of a projecting plunger or mandrin. At first the mandrin had a rigid end; later flexible tips were added. To all intents and purposes the elastic bougie is a mandrin with a flexible tip and is so used today. The mandrin is chiefly employed with the finger tip introduction of the esophagoscope or the gastroscope. There is no great or vital objection to the use of the mandrin if the examiner is sure that the pathologic condition is well down the esophagus or if, as in gastroscopy, he is to pass the tube through a normal esophagus. The procedure is carried out as follows: The examiner holds the esophagoscope in the right hand and with his thumb steadies the head of the plunger. With the forefinger of the left hand he feels the right arytenoid cartilage by forcing his finger well down the patient's pharynx. Along the inner surface of the left forefinger of the examiner the esophagoscope is carried into the right pyriform sinus. When the end of the instrument has reached this

point a little twist of the end of the tube to the left carries the tube into the esophagus. With a tube of medium or small diameter this method of introduction is the quickest and easiest. The disadvantage of the procedure need not be dwelt upon after what has been said of the advantage of the introduction by sight. The large oval tube which is used by the author is fitted with a conical rigid plunger which projects from the end of the tube an inch and a half. The plunger is used in those cases in which the ocular introduction of the oval tube does not succeed. The oval tube is carried down by sight and the attempt is made to pass it by sight after the method which has just been described. If this fails the plunger is put in and gently forced home. The plunger is so long and pointed that it finds its way behind the cricoid cartilage, dislocates it forward and allows the tube to follow on after it.

The introduction of the esophagoscope with flexible bougies is best adapted to round tubes. The bougie can first be introduced by the finger tip method or the tube can be carried to the entrance of the esophagus by sight and then the bougie passed through it and into the esophagus. The tube may then be slipped down over the bougie.

The impression may have been given by what has been said concerning the introduction of large tubes that they should be used at all costs. This is not the impression which the author wishes to leave. If a large tube can be used, and it can be used under ether without danger oftener than is generally recognized, it should be employed. It must be remembered, however, that if the introduction of a chosen tube is not easily successful, that tube should be discarded at once for a smaller one. Obstinacy on this point will lead to disaster.

The Appearance of the Normal Esophagus.—Under good illumination the color of the mucous membrane of the esophagus is a whitish pink like that of the mouth. Poorly lighted or when inflamed the color changes to a red of varying depth. After trauma, the mucous membrane soon becomes edematous. When examined with small tubes the walls of the esophagus are thrown into large longitudinal folds, and on looking through the tube they are seen indenting the circumference of the central dark area which represents the lumen of the esophagus. These folds are especially numerous at the mouth of the esophagus behind the cricoid cartilage. They make it hard to be sure of the pathologic lesions in this locality. Below the cricoid cartilage and in the cervical region the lumen is seen to enlarge with inspiration and to close down again, but not entirely, during expiration. When a large tube is used the examiner can often look down the esophagus a long way ahead of it. As the esophagoscope reaches the first piece of the

sternum the pulsation of the arch of the aorta can be seen through the anterior wall. A little lower the heart mounds into the anterior wall on the left. The beating of the heart is visible and when the tube has passed beyond and the heart lies against it, the tube often

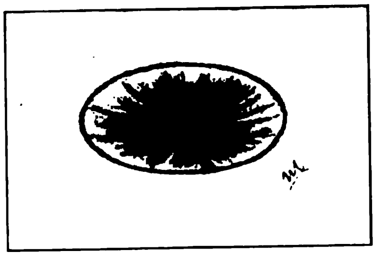


Fig. 168.

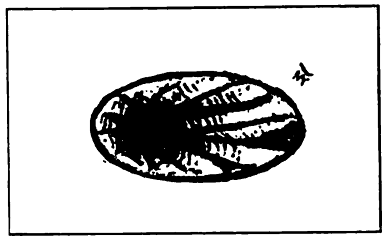


Fig. 169.

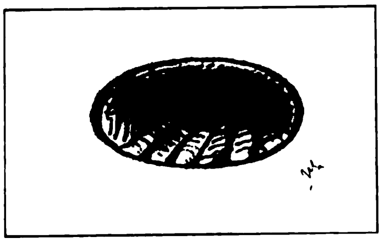


Fig. 170.

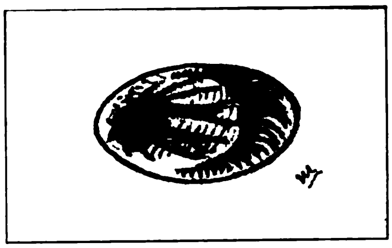


Fig. 171.

Fig. 168.—The normal esophagus above the hiatus of the diaphragm, and with the diaphragm contracted.

Fig. 169.—The esophagoscope has been pushed through the hiatus of the diaphragm and entered the subphrenic portion of the esophagus. The characteristic longitudinal folds of this part of the esophagus are shown. They converge to the left upon an ill-defined transverse slit which is the cardiac opening.

Fig. 170.—The esophagoscope has been carried through the cardiac opening of the esophagus into the stomach. The stomach appears as a funnel-shaped cavity. On the lower wall of this the rugæ of the stomach are seen.

Fig. 171.—The drawing shows the esophagus just above the hiatus of the diaphragm. The patient was examined under ether and with an oval esophagoscope. On the patient's right the rim of the hiatus is partially contracted and mounds into the lumen of the esophagus. Later in the examination when the diaphragm became fully relaxed this ridge disappeared. Below and beyond the ridge the subphrenic portion of the esophagus is seen. The characteristic longitudinal folds veer to the left and end in the cardiac opening. The cardiac opening is in a state of spasm.

(Drawings by the author.)

vibrates in unison with the heart beat. The hiatus of the esophagus appears as a slit on a rosette. The axis of this opening through the diaphragm is oblique, running from right to left, from behind forward. The subphrenic portion of the esophagus usually shows no lumen, but

Fig. 172.

Fig. 173.

Fig. 174.

Fig. 175.

Fig. 176.

Fig. 177.

Fig. 172.—Normal esophagus during quiet breathing. Small esophagoscope.
Fig. 173.—Normal esophagus during deep respiration.
Fig. 174.—Stricture of esophagus with scars radiating from its lumen.
Figs. 175 and 176.—Carcinoma of the esophagus.
Fig. 177.—Fish bone in the esophagus.

(After Stark.)

opens as the tube passes through it. The mucous membrane of this part is so much like that of the stomach that it is hard to tell where the esophagus ends and the stomach begins. The mucous membrane of the stomach, however, is a darker red than that of the esophagus and the longitudinal folds of the esophagus give place to the familiar rouge.

The mouth of the esophagus and the hiatus are the two places where it is always difficult for the examiner to be sure of his findings. The difficulty at the first place is due chiefly to the folds of the mucous membrane. These can be stretched out by passing the esophageal dilator well into the mouth of the esophagus and opening it sufficiently to displace the cricoid cartilage strongly forward. If a true web is suspected the withdrawal of the open dilator will make its size and position plain. The introduction of a small tube through the pyriform sinus is very liable to push a fold of the mucous membrane ahead of it and produce an artificial web or fold. Once the cricoid cartilage has been passed the further progress of the esophagoscope is usually easy. The examiner should always see the open esophagus ahead through the tube before the tube is advanced. When no lumen appears the end of the tube is generally pointed too much to the side and is out of line with the long axis of the esophagus. If, on correcting the position of the tube, the lumen of the esophagus is still unnoticeable, its position can be made out by inserting the window plug and filling the esophagus with air. The author considers this expediency of the utmost value. Once the lumen has been found the tube can be carried further down.

In order to enter the hiatus it is necessary to carry the shaft of the esophagoscope to the right corner of the mouth and the point of the tube to the left, beginning the search in the right posterior quadrant of the esophagus. It is at this point that the hiatus is most readily found. When the point of the tube cannot be made to enter the hiatus and to proceed through the kinked subphrenic portion of the esophagus, a bougie passed through the esophagoscope and into the subphrenic portion will often guide the tube into the stomach. The author relies upon ballooning the esophagus and thus finding his way. After the esophagus has been examined all the way to the stomach the tube is withdrawn and the whole of the esophageal wall is reexamined.

THE DISEASES OF THE ESOPHAGUS.

The chief symptom of disease of the esophagus is obstruction to swallowing. Diseases of the esophagus, therefore, fall into two groups, those which cause marked stenosis and those which do not. New

growths form an important subgroup. As elsewhere in the body a new growth may be benign or malignant. Foreign bodies in the esophagus make the final important group to be considered.

DISEASES OF THE ESOPHAGUS WHICH CAUSE STENOSIS.

Acute Inflammation.

Following the swallowing of a corrosive such as lye (washing powders), carbolic acid, or corrosive sublimate, the esophagus becomes acutely inflamed and more or less completely closed. Rough, impacted foreign bodies also cause a local inflammation. This may be more or less general if the foreign body has caused extensive trauma.

After the swallowing of a caustic it is better to wait for a few weeks, perhaps a month or two until the inflammatory disturbance has subsided before examining the esophagus with the esophagoscope or before passing bougies by the aid of the esophagoscope in the hope of preventing the formation of cicatricial strictures. This caution is especially necessary in dealing with young children. In such cases it is probably better to open the stomach without delay and to nourish the child through the gastric fistula until it has regained its powers of resistance and is once more well nourished. If a foreign body has caused the inflammatory stenosis of the esophagus, it must be removed at once.

Stenosis of the Esophagus Due to Cicatrices.

Cicatricial stenosis of the esophagus may be the result of operation, i. e., removal of the glands of the neck, or excision of the larynx. Traumatic stenoses are caused by gunshot wounds and by swallowing sharp foreign bodies. Systemic diseases, which are at times associated with ulcerations of the esophagus, may also cause cicatricial stenoses. Syphilis and typhoid fever are occasionally responsible for such strictures. Pneumonia may produce the same condition, but cicatricial strictures are most common after the swallowing of some escharotic. When home-made soap was common, children drank it by mistake. Today they drink solutions of corrosive sublimate, which are kept to destroy vermin, or the various washing compounds containing caustic soda.

It may be years before cicatricial strictures finally shut down. Adult patients not infrequently present themselves who give a history of having swallowed some caustic in childhood and who have had only moderate difficulty in swallowing for years.

The Location of Strictures.—Caustic strictures form most readily at the point where the esophagus is the narrowest. They are found,

therefore, most commonly at the upper or lower end of the esophagus. Occasionally a stricture is found at the level of the clavicles. Not uncommonly there will be a stricture at the level of the clavicles and a second and larger one at the cardiac end of the esophagus. The usual tight stricture is about an inch long. At times the whole lower half of the esophagus is narrowed, making one long stricture. The author met this condition once as the result of ulcerations of the mouth. pharynx and esophagus during pneumonia. Partial band-like strictures may precede and guard the opening of the chief stricture. The esophageal wall above a stricture is dilated. This sac-like pouch engages the end of a bougie and keeps it from finding the lumen of the stricture easily. When, however, the esophagus is examined with the esophagoscope, especially if a tube of good size is used, the lumen of the stricture is easily made to come opposite the end of the tube. (Fig. 176.)

The Diagnosis and Treatment of Esophageal Strictures.—The best method of determining the presence of an esophageal stricture is to pass the esophagoscope. The larger the examining tube the easier it is to find the constriction and to make the lumen of the stricture center with the end of the tube. The mere presence of a stricture can be made out with a small tube and the examination carried on under cocain anesthesia. The accurate mapping out of a stricture, however, and its maximum dilatation are possible only under general anesthesia. For this reason the author feels that time is wasted in examining a cicatricial stricture under local anesthesia. When, therefore, a patient is to be examined for a cicatricial stricture he should be etherized and placed on the examining table with the head hanging over the edge and as large a tube introduced as can be made to pass the cricoid cartilage easily. Under direct vision the tube is carried down to the stricture and the lumen of the stricture made to correspond with the center of the tube. The author's experience has been that this is easy to accomplish. Occasionally ballooning the esophagus with air helps to find the opening of the stricture. After the dilatation of a small stricture has been begun the ballooning is an easy way of keeping the blood out of the mouth of the stricture. To return, after the stricture has been found and its opening centered at the end of the tube, the lumen of the stricture should be tested with an elastic bougie of appropriate size. If it happens that the lumen measures 20 F. or is easily dilatable with soft bougies up to this calibre, the metal dilator (Fig. 178) is carried by sight through the stricture and the dilating mechanism expanded until marked resistance is felt. The dilator is kept expanded for two or three minutes and then closed. After a

short interval the stricture is again put on the stretch. By coaxing the dilatation a marked gain in the lumen of the stricture is soon attained. It is surprising how readily even old strictures will yield. The author so far has not found it necessary to cut a stricture in order to make dilatation possible. No rule can be given as to how fast to dilate or how much. Until more data have been accumulated upon this point the operator must use his best judgment. The aim is to get the maximum dilatation so that a good sized bougie can be passed easily after the examination. In a boy of seven years with a year old corrosive

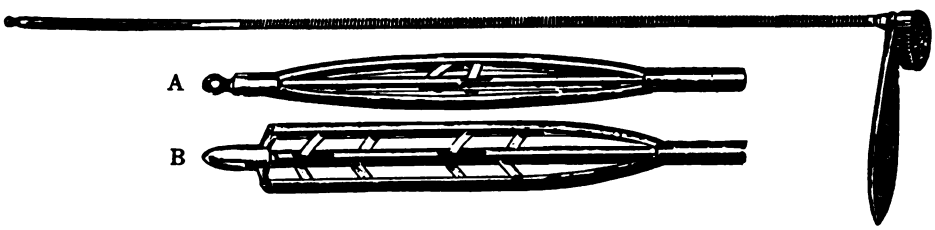


Fig. 178.

Mosher's mechanical dilator, with two tips. A, tip for use in stricture of the esophagus; B, tip with larger expansion for use in cardiospasm.

stricture which would not admit a 16 F. bougie without ether and in whom under ether a 20 F. passed firmly, I was content with a dilatation to 34 F. In a woman of forty with a stricture which had existed since childhood and which admitted without ether a number 20 F. bougie with difficulty, the dilatation was carried carefully up to 42 F. This was sufficient to allow the passage after ether of a 32 F. bougie. The dilatation was subsequently increased by the weekly passing of elastic bougies up to 36 F. Rapid dilatation under ether saves months of

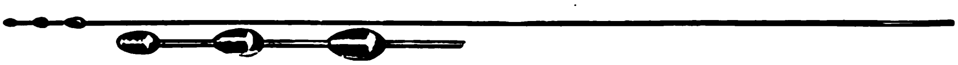


Fig. 179.

Modified Bunt's olive-tipped metal bougie. This instrument is used for starting the dilatation of small strictures of the esophagus.

time. Experience has proved that rapid dilatation is safe if carried out with ordinary caution.

In the treatment of strictures in which the lumen is so small that the smallest elastic bougies will not pass, much can be accomplished by the gentle use of a staff carrying small metal olives (Fig. 179.) With the smallest olive an eighth or a quarter of an inch of the stricture is picked or teased open. After this an elastic bougie of slightly larger size is introduced in the hope of increasing the dilatation. The use of

the metal olive should be most guarded. All the while the operator must be conscious of the true axis of the esophagus because any deviation from the proper line will result in a perforation and the probable death of the patient. In long tight strictures it is not necessary that the lumen be restored through the whole length of the stricture at the first sitting, because experience has proved that it is better in such cases to open the stomach at once and to get the patient properly nourished before very tight or very long strictures are dilated. When an emaciated, half-starved patient presents himself, and especially in the case of children, it is better surgery to open the stomach at once and to restore the patient's resistance by feeding before attempting the dilatation of a difficult stricture. If this had been done there is no hurry so that the stricture may be opened up gradually.

The following histories are given as illustrations of typical cases of stricture:

Case Number 1.—A boy two years old drank a caustic solution and three months later developed marked difficulty in swallowing. Milk became his only food. One day this would stay down, the next the greater part of the milk would be regurgitated soon after it was swallowed. A number 16 F. elastic bougie met with resistance at the lower end of the esophagus and would not enter the stomach.

Under ether a stricture was found at the cardiac end of the esophagus, and a moderate dilatation of the esophagus above it. The stricture proved to be an inch long. It dilated readily with elastic bougies to 20 F. From this measurement the dilatation was carried to 32 F. with the mechanical dilator. As was just said it was impossible to pass even a small bougie into the boy's stomach before the etherization and dilatation, but afterwards a number 32 F. could be introduced easily. The family physician passed a number 32 F. bougie once a week. The boy soon became well nourished again. At the end of a year and a half the mother of the child reported that he had no difficulty in swallowing.

Case Number 2.—A woman in the forties gave a history of marked difficulty in swallowing for two months, and of pain in the epigastric region. She was moderately well nourished and was living on milk and soft solids. The patient stated that when she was a small child a playmate offered her a drink of vitriol. Since this happening she had had a moderate and stationary amount of trouble with swallowing. For the last month, however, the trouble had suddenly increased and she had begun to have pain in the region of the stomach.

A number 20 F. bougie encountered resistance at the cardiac end of the esophagus and entered the stomach with difficulty. The X-ray showed that the lower half of the esophagus was narrowed.

The ether examination disclosed a stricture at the level of the clavicle. The lumen of this was about 30 F. This stricture was easily dilated with the mechanical dilator so that it permitted the passage of a tube measuring half an inch. A second stricture was found at the cardiac end of the esophagus. The second and lower stricture was dilated with elastic bougies up to 22 F. and then the mechanical dilator was introduced and the stricture stretched slowly and at intervals of a few minutes up to a final dilatation of 42 F. At this point the resistance to the dilatation became extreme and it was discontinued.

Fig. 180.

Stricture of the esophagus. (Tracing from an X-ray plate, retouched and reduced.)

This plate was taken from a woman forty years old. At the age of four a playmate gave her a drink of vitriol. Since then she has always had to chew her food very fine. For a month or two before she came for examination she had been living on liquids.

A No. 20 F. elastic bougie entered the stomach with difficulty, encountering a stricture at the cardiac end of the esophagus. The X-ray plate shows that the lower half of the esophagus is narrowed. Under ether a stricture was found at the end of the clavicles as well as at the cardiac end of the esophagus. This had a calibre of 28 F. The upper stricture was dilated first with the mechanical dilator and then the lower one. The lower stricture was dilated at the first examination from 20 F. to 32 F.

The instrumentation was not followed by any rise in temperature, but for a few days there was an increase of the epigastric pain, and for three or four days the ability to swallow was lessened. By the end of the week the pain had disappeared and the patient was swallowing better than before the operation. At this time a number 30 F. elastic bougie passed without difficulty. For about a year afterwards bougies were passed on the average of every two weeks. Today a number 36 F. passes without difficulty and the woman eats everything.

This case shows that where there are two or more constrictions the bougie locates only the smaller one. From the age of the lower stricture and from its firmness at the beginning of the dilatation the author was of the opinion that it would have to be cut before any increase of its lumen could be accomplished. A little patience in the use of the mechanical dilator, however, soon proved that this supposition, however natural, was wrong. This case shows, therefore, the possibilities of rapid dilatation even in old strictures. It shows further, that the bismuth X-ray examination reveals only the upper stricture and gives a false impression of the condition of the esophagus below the first narrowing.

Case Number 3.—Two years ago a boy of five was brought to the Massachusetts General Hospital starving from the effects of a corrosive stricture of the esophagus. His stomach was opened under cocain anesthesia, a tube inserted, and the boy brought back to proper nourishment and resistance by stomach feeding. Then attempts were made to pass the stricture from above by introducing bougies and by having the boy swallow a string to act as a guide for a perforated olive on a metal staff. These attempts failed. The attempt also failed when the stricture was attacked from below through the gastric fistula by means of a cystoscope.

A year later the boy again entered the hospital. He was still fed through a tube in the gastric fistula. He was at this time the picture of health, fat and pink. The X-ray revealed a constriction of the esophagus beginning at the level of the nipples and continuing on to the stomach. Above the stricture the esophagus was much dilated. Examination with chemicals proved that nothing could reach the stomach.

Dr. S. J. Mixter, to whose wards the boy was admitted, kindly asked the author to see the case. The examination under ether showed that the upper half of the esophagus was dilated and that the stricture began as the X-ray had shown, at the level of the nipples. The lumen of the esophagus was reduced to a central opening about one-sixteenth of an inch in diameter. A filiform bougie would just engage in this and then would enter no farther. Having gained this information from above an attempt was made to pass the stricture from below through the gastric fistula, by using a small short bronchoscope. This was not successful. Then Dr. Coolidge took the bronchoscope and worked from below while the author worked in the esophagus from above using a small esophagoscope. This double attack on the stricture made no gain and the manipulations from below were discontinued. The author soon found that on using the small metal olives on the end of a metal staff the lumen of the stricture could be entered a short distance, perhaps an eighth of an inch. Encouraged by this he persisted in the use of the metal olive using first the metal olive and then a small elastic bougie of slightly larger size. The result of the first day's work was the ungluing of about an inch of the stricture. No reaction followed the manipulations.

Two weeks later the boy was etherized again and the same manipulations repeated. A second gain of nearly an inch was secured. During this second session at the stric-

ture the ballooning attachment was employed from time to time in order to clear the blood from the lumen of the stricture and in the hope that some of the air might find its way into the stomach. Air finally did enter the stomach and could be detected coming out of the gastric fistula. This happening was most comforting and encouraging. It proved that the metal olive was following the right line and that the lower inch of the stricture was pervious to air. Without the confidence which this finding gave the author might have given up the attempt to pick apart so long a stricture, because if the line of the stricture was not adhered to closely the olive would perforate the walls of the esophagus and convert the case into a tragedy. After a second interval of rest, about two weeks, the boy was etherized for the third time. The gain made at the other examinations was found to be retained. Air still could be forced into the stomach, and aft a little manipulation the olive also entered. This was followed by soft bougies until the lumen of the stricture was increased to 20 F. The mechanical dilator was then put in and expanded at intervals to 28 F. The manipulations ended by carrying into the stomach a thread and bringing the upper end of this out of the mouth and fixing it over the ear.

Three or four days later the perforated metal olive on a long staff was carried down on the thread into the stomach. The boy began to drink milk. It was soon possible to pass the olive through the stricture without using the string as a guide. This was fortunate because the thread was vomited after a few days. The further treatment of the case consisted in passing larger and larger olives at appropriate intervals until a final dilatation of 36 F. was reached.

In this case an absolute stricture three inches long and a year old was opened up piecemeal with a final lumen of 36° F. The previous treatment of the case along general surgical lines had failed. This fortunate case, therefore, shows in a striking manner the possibilities of the treatment of strictures by the esophagoscope and by appropriate instruments used through it.

The Use of a Thread as a Guide in Esophageal Strictures.—The procedure of having the patient swallow a thread was a great advance in the general surgical treatment of strictures of the esophagus. It is mentioned in connection with the use of the esophagoscope because occasionally advantage may be taken of this procedure in connection with the use of the tube. The swallowed thread may be used to guide the esophagoscope to the lumen of the stricture, although as the operator becomes accustomed to the use of the esophagoscope and resorts to ballooning, he will find the swallowed thread less and less necessary. The chief use of the thread is its employment as a guide for the metal olive after the rapid dilatation. When used in this way a yard or two of stout waxed thread is wrapped about a small button and the button is carried into the stomach through the tube during the examination and after the stretching. The upper end of the thread is brought out of the mouth and fastened over the ear. Generally the use of the thread as a guide for the metal olive and its staff is necessary for a few days only, because the operator soon becomes orientated in regard to the lumen of the stricture and finds that the metal staff allows him to turn

the olive in different directions and to probe for the opening of the stricture successfully.

The Spiral Staff for Carrying Olives.—The purpose of introducing the metal olive and its staff is that olives of increasing size may be passed on the metal shaft until the dilatation of the stricture is such that the passage of elastic bougies is possible. (Fig. 183.) Instead of forcing the perforated olive down the staff and through the stricture by a second staff carrying a ring placed at right angles to the shaft, better

Fig. 181.

Handle and staff of Plummer's esophageal whalebone bougie.

Fig. 182.

Whalebone staff of Plummer's esophageal bougie fitted with two olives. The first olive is pierced to run on a thread. The olives are made in graduated sizes.

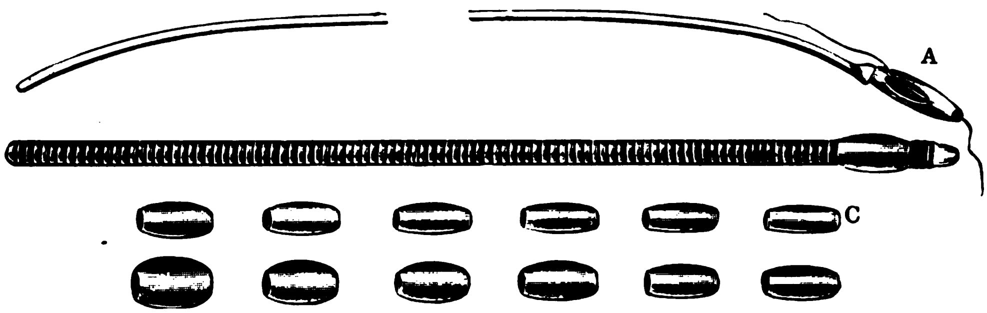


Fig. 183.

A, Metal staff carrying a perforated olive at the tip (Mixter); B, Special wire carrier (Mosher), on which various sizes of olives are screwed; C, Graduated olives.

results can be obtained by employing the spiral wire carrier. The flexible pusher buckles away from the line of the main staff, and so at times refuses to push a snug olive through the stricture. The spiral wire carrier, on the other hand, hugs the guiding staff closely and gives a direct push on the olive. When the olive is in position against the stricture if the operator puts his finger in the patient's pharynx and presses downward on the spiral staff, he can exert great pressure on the olive below. In fact, the author found that this method of forcing an olive through a

stricture was so powerful that care was necessary or the stretching of the stricture would be too rapid and followed by a reaction. A series of olives of increasing sizes comes with the spiral staff. An olive of any size can be extemporized. In the case of the boy (Case 3, page 237) an olive of the desired size not being at hand, an olive was wound on the staff by using coarse surgical silk. The silk was given a smooth coating by smearing it with modeling compound, such as dentists use for taking impressions of the teeth. The spiral staff permits two or more olives of increasing size to be put on at once. These may be placed at intervals after the fashion of Bunt's bougie. (Fig. 179.)

The After-care of Stricture of the Esophagus.—When a stricture of the esophagus has been dilated sufficiently to permit the patient to swallow readily, bougies of maximum size must be passed at intervals of a week or two or monthly, for months or years. Not infrequently adult patients learn to pass the bougie upon themselves.

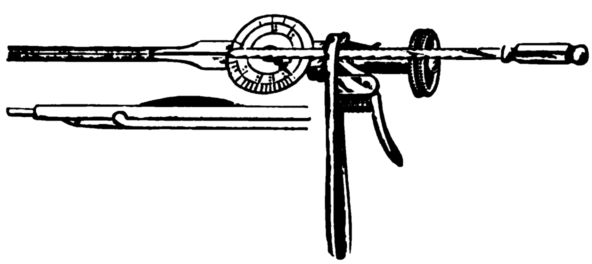


Fig. 184.
Mosher's two-bladed dilator with sliding knife for cutting strictures of the esophagus.

Spastic Stenosis of the Esophagus.

Esophagospasm (Esophagismus).—Esophagospasm is an excessive irritability of the esophagus. It prevents the introduction of the esophagoscope under local anesthesia. Under general anesthesia, however, the esophagoscope passes easily. On examination the esophagus is found to be normal, or if any lesion is discovered it is almost always a simple ulceration. Esophagospasm is the underlying condition in globus hystericus. It should be remembered that a diagnosis of globus hystericus is made less and less often since the use of the esophagoscope has become common. On this account the diagnosis should always be looked upon with suspicion.

The treatment of esophagospasm is to pass the esophagoscope under ether anesthesia and to treat any ulceration present with some mild caustic. If the esophageal wall proves to be normal the regular passing of elastic bougies in time establishes tolerance and does away with the sensitiveness of the esophagus.

Cardiospasm.—Cardiospasm is the name applied to a condition of spasmodic closure of the esophagus at the cardiac opening of the stomach. The name, however, is used in connection with spasmodic closure of the esophagus at any other point. This condition is one of the most important pathologic affections of the esophagus. Its etiology is still obscure. Jackson holds that the cardia is not a true sphincter in spite

Fig. 185.
Cardiospasm. Retouched tracing from an X-ray plate. The esophagus is filled with bismuth gruel, and is narrowed to a very small lumen. Above the narrowing it is dilated. (Author's case.)

of the circular fibers of Hyrtl, but maintains that the hiatus is an actual sphincter and acts as one. In cardiospasm there are two chief features, spasm of the cardia and dilatation of the esophagus. In the majority of the cases there is atony of the muscular wall as well. The conditions which are responsible for these changes have been held by various writers to be a congenital defect, a primary neurosis, or an esophagitis. In some cases the atony is primary to the spasm and dilatation, in others

the spasm comes first. Lerche maintains that an attempt should be made from the clinical histories to divide cases into the two classes just mentioned. Gottstein gives the following classification: (A) Cases in which excessive spastic muscular contractions take place. (B) Cases in which the contractility of the muscles is weakened or lost. (1) Cases are classed as idiopathic in which no organic lesion can be demonstrated, (2) as secondary or symptomatic when due to some anatomic alteration as ulcer or cancer.

Under class A (excessive muscular contraction) are grouped: esophagospasm and cardiospasm. The first involves the esophagus proper and the second only the cardia. Cardiospasm may be acute or chronic.

Leichtenstern defines cardiospasm as a pathologic exaggeration of a physiologic phenomenon, due to abnormal innervation of the cardia. It produces an habitual, non-permanent, spastic closure of the cardia. This is greater than normal, lasts a long time, and occurs especially after meals. It is not known whether the condition is caused by a failure of the inhibitory nerve fibers which control the normal tonus of the cardia or to some irritation which causes an increased tonus in the contraction fibers.

Frequency of Cardiospasm.—Both sexes are affected equally. The majority of the cases occur between the ages of twenty and forty, but cases have been reported in which the patients were eight and four years old. The latter case was one of acute cardiospasm.

Anatomic Considerations.—According to Rumpel the capacity of the esophagus varies between 40 cc. and 80 cc. but even 150 cc. may be considered within physiologic limits. The position of the cardia changes with age. In the infant it is found at the level of the eighth dorsal vertebra whereas in the aged it may be placed as low as the twelfth dorsal vertebra. In the neck the esophagus is closed, but in the chest it is open and contains air. Mikulicz found that the intraesophageal pressure during rest was a little below that of the atmosphere. By quiet inspiration the pressure is lowered to 9 cm. water pressure and by forced inspiration to 20 cm. below. On quiet expiration the pressure rises to 10 cm. water pressure, and by forced expiration to 20 cm. Coughing may raise the pressure to 60, 80, or even 160 mm. mercury. On swallowing the pressure varies between 0.80 and 22 cm. water. The normal esophagus opens easily without the aid of swallowing for the passage of fluids and gases from the esophagus into the stomach, but opens with difficulty for their passage in the reverse direction. The pressure necessary to open the cardia amounts to a fraction of the pressure of a column of water filling the thoracic portion

of the esophagus. When irritating fluids such as very hot or cold liquids or carbonized drinks are taken the pressure necessary to force them down is higher.

If the resistance of the cardia is increased, a part of the fluid swallowed will remain in the esophagus. Suppose that in order to effect automatic opening of the cardia under normal conditions a pressure of 12 cm. water pressure is necessary. In this case the excess of fluid over 12 cm. would flow into the stomach by its weight, leaving behind a 12 cm. column of fluid. The next act of swallowing which corresponds to about 12 cm. water pressure would carry this into the stomach. If the resistance of the cardia corresponds to 24 cm. water pressure, there will be left a column of 12 cm. at the end of the act of swallowing. If the resistance of the cardia is still higher only so much fluid will pass the cardia as is pressed down by the muscles of the pharynx. The esophagus itself can overcome the resistance of the cardia only by energetic contraction. In a normal esophagus the effect of this increased pressure on the esophagus is small but as soon as the esophagus becomes dilated the effect of the increased pressure which is necessary to force food through the unyielding cardia is to make the esophagus dilate more and more. Stagnating food leads to changes in the esophageal wall which further weaken it.

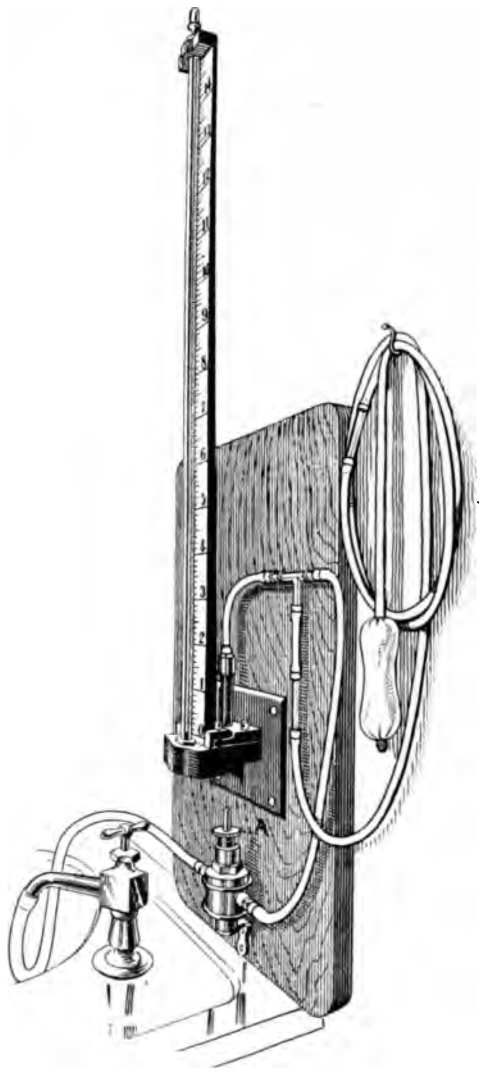


Fig. 186.
Apparatus for dilating the cardia. (After Lerche.)

Mikulicz used the esophageal pressure during swallowing as an indication of the contractile power of the esophageal muscles. He therefore measures this pressure. Lerche has devised an apparatus for doing this. (Fig. 186.)

THE SYMPTOMS OF CARDIOSPASM.—The two chief symptoms of cardiospasm are difficulty in getting food into the stomach, and frequent regurgitation. Often the patient has a troublesome cough at night, or is awakened by food running back into the pharynx and into the nose. If the condition has existed for some time the patient is much emaciated.

EXAMINATION.—The history of the patient should exclude syphilis, and the swallowing of caustics or foreign bodies. In the general physical examination of the pressure from an aneurism, a goitre, or a tumor in the mediastinum should be constantly borne in mind. The esophageal examination should be ruled out in the presence of ulcers, and of malignant or benign growths. It must be remembered that a large or a low seated diverticulum of the esophagus may be present.

Much light is often thrown on a case by filling the esophagus with bismuth and then taking an X-ray plate.

The Examination Under Local Anesthesia.—A large sized elastic bougie is introduced into the esophagus and the distance of the obstruction from the incisor teeth is found. In a case of cardiospasm the bougie will occasionally pass through the cardia easily or on gentle pressure, at other times much pressure is needed to force it through. The esophagus is washed out and the throat cocainized. Then the esophagoscope is passed and a careful examination is made of the esophagus. The condition of the mucosa and of the esophageal walls is noted. It should be ascertained whether the walls are firm or flaccid and whether the esophagus is normal in size or dilated. Ulcerations, diverticulum and new growths are excluded. When the tube reaches a proper depth the cardia is seen as a slit with the long diameter lying obliquely from the right posteriorly to the left anteriorly. This is not the cardia strictly speaking, but the hiatus of the esophagus, though many writers use this name for the constriction of the esophagus at the point where it goes through the diaphragm. The hiatus appears either as a slit or as a rosette. In spasm it is usually like a rosette. It has been compared to the mouth of the cervix uteri. (Fig. 168.) The esophagoscope cannot be passed in cases of cardiospasm into the stomach without first cocainizing the hiatus. As soon as the hiatus gives way the tube is carried into the stomach and then withdrawn. On the withdrawal the esophagus is examined again in order to confirm the negative findings.

In a complete examination the next step is to determine the capacity of the esophagus. An esophagometer is used for this purpose. Lerche has devised an instrument of this nature. It consists of a rubber bag which is inserted into the esophagus and then filled with air. A recording mechanism registers the amount of air necessary to make

the bag assume the same dilatation and shape as the esophagus. An X-ray picture may be taken with the bag in place. This will demonstrate the shape of the dilation more sharply than the bismuth gruel.

The Treatment of Cardiospasm.—The treatment of cardiospasm consists in stretching the hiatus of the esophagus. This can be effected with a pliable dilator like a rubber bag, or with an instrument modeled on the principle of the urethral dilator. The rubber bags are generally used under local anesthesia. The apparatus used by Lerche is shown in Fig. 186. It consists of a stomach tube the end of which is covered with a sausage-shaped silk bag 10-12 cm. long. The bag is distended by connecting the apparatus with a water faucet. A secondary mechanism regulates the amount and the pressure of the water and so the pressure exerted by the bag when it is in place.

The use of bougies in pronounced cases of cardiospasm for dilating the hiatus does not give good results.

Gumprecht has stated that the maximum dilatation to which the normal cardia can be stretched is respectively 3 cm. and 3.5 cm. Scheiber found that the normal cardia from the stomach side could withstand a pressure of 350 grams for a few seconds. Strauss distended the rubber bag with air and had his apparatus so regulated that a pressure of not more than 250 cm. of mercury could be brought upon the cardia. Jacobs using a mechanical dilator fashioned on the plan of the urethral dilator stretched the cardia to a diameter of 3.5 cm. Mikulicz working from within the stomach stretched the cardia to a diameter of 7 cm.

The Treatment of Cardiospasm Under Ether.—An examination under ether is much easier for the patient. The stretching of the cardia with the mechanical dilator is much simpler than the use of the rubber bags. There is one drawback, however, to the examination under ether. All spasm of the esophagus is done away with and the cardia itself may so be relaxed that unless the examiner bears this fact in mind he may feel that he has not found the cause of the condition for which the examination is undertaken. After the ether examination in cases of cardiospasm and the dilatation of the cardia the author has been in the habit of leaving a thread in the esophagus and in the stomach and of passing the olive tipped staff on the thread for a few days until it was possible to pass the staff unguided. On the staff metal olives of increasing size are passed for a time and then the unguided elastic bougie. Finally the patient is taught to pass the bougie for himself. This he does at intervals according to the persistence of the spasm.

The relief of cardiospasm is easily brought about. The patient's symptoms lessen almost immediately. Measurements show that the

esophagus soon contracts unless there has been extensive weakening of the esophageal walls. Cases of this kind, although they obtain marked relief from stretching of the cardia, naturally still have a certain amount of residual trouble on account of the slowness with which food passes the weakened esophagus. Cases of cardiospasm

Fig. 187.

Cardiospasm. From a print of an X-ray plate, showing a dilated esophagus. The esophagus narrows to a point in the shadow of the diaphragm. (Plate by Dr. F. H. Williams.)

are among the most dramatic of surgery. The following case is an example: A young woman had been regurgitating her food for fifteen years. She went from physician to physician. She was constantly eating but was always hungry, and consumed enough food for two or three people but continually wasted away. When she lay down, food regurgitated into her mouth or her nose. This and a constant cough kept her awake. In a short ether examination lasting about the same number of minutes as she had been ill years the cause of the trouble was discovered and practically cured. (Fig. 187.)

Phrenospasm.—Phrenospasm is the name applied by Jackson to spasmodic closure of the esophagus at the hiatus. This condition is frequently seen in passing the esophagoscope without anesthesia. Frequently the esophagoscope is hugged so tightly that the subphrenic portion of the esophagus cannot be entered. Under general anesthesia the spasmodic closure of the hiatus disappears. This characteristic disappearance of the spasm together with a normal mucosa establishes the diagnosis of phrenospasm. Almost invariably the esophagus is dilated above the hiatus.

Jackson makes a clear distinction between spasm of the cardia and spasm of the hiatus. Many authors do not, but speak of spasm of the cardia when in reality they mean spasm of the hiatus. Then again the term spasm of the cardia is used to mean spasm either at the cardia or at the hiatus. Jackson's terminology leads to clearness.

Benign New Growths of the Esophagus.

Benign neoplasms of the esophagus occur but are not common. When it becomes the routine to examine all cases of slight trouble with swallowing in all probability more benign new growths will be discovered. Edematous polyps and pedunculated lipomata are probably the commonest of the benign growths. Fibromata also occur.

These benign growths are found chiefly in the upper part of the esophagus. Their pedicles allow them to play up and down so that they appear at one examination and may disappear at the next or they are present when the examiner first looks into the throat with the mirror and they disappear when the patient swallows. Pedunculated lipomata have a fashion of dropping forward into the larynx and of causing cough and intermittent hoarseness.

Treatment of Benign New Growths.—Benign new growths should be removed with appropriate grasping or cutting forceps. An effort should be made to obtain as much of the pedicle and its base as is possible. Sometimes the manipulations can be carried out through the tubular speculum, whereas at other times the esophagoscope is

necessary. The accessibility of the growth and the tolerance of the patient settle the question of the use of local or general anesthesia. With the exception of lipomata all supposedly benign growths are looked upon with a certain amount of suspicion. In any given case time alone can settle whether or not this suspicion is well founded.

Malignant New Growths of the Esophagus.

Any persistent difficulty of swallowing in a patient of the cancer age ought to lead to a prompt examination of the esophagus. Only in this way can malignant disease be detected early and the cases which are fit for operation sorted out. Cancer of the esophagus often gives

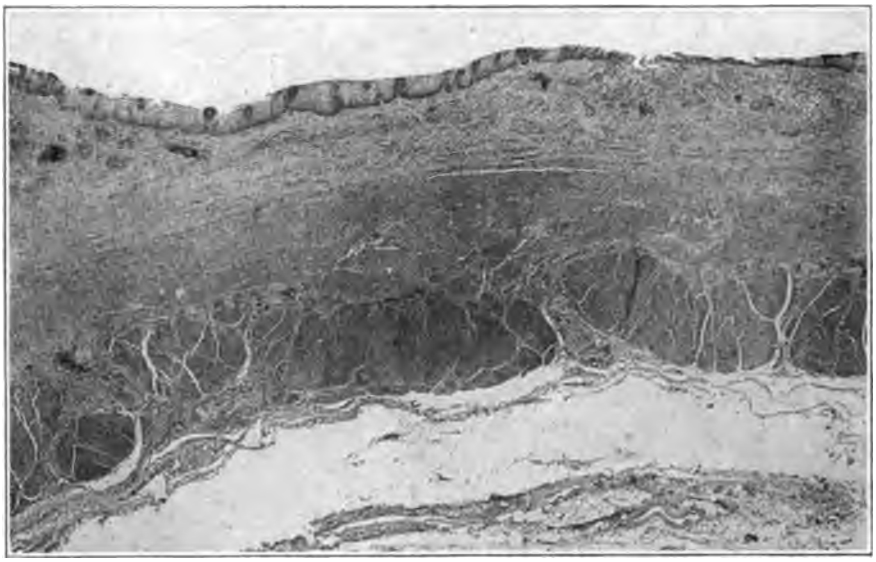


Fig. 188.
Section of normal esophagus (Low power).

but slight symptoms for a number of years. It is not uncommon to have patients give a history of trouble with swallowing dating back three or four years. The horrors of cancer are nowhere greater than in cancer of the esophagus. If for no other reason, therefore, these patients should be given the benefit of an early examination and of an early diagnosis.

Malignant disease may start in the epithelium of the esophagus, or in its muscular wall, or outside of it. In late cases no conclusion can be arrived at as to origin of the disease.

Periesophageal disease, when not far advanced, appears through the esophagoscope as a hard nodule projecting into the lumen of the esophagus and over which the mucous membrane is normal.

Gottstein, quoted by Jackson, describes the appearance of cancer of the esophagus under five heads.

1. The esophageal wall shows thickened whitish patches. These white patches alternate with patches of bright red.
2. There is a ring-like narrowing of the lumen of the esophagus. This is called the annular form. At some point in the ring there is usually ulceration. Frequently the esophagus is dilated above the constriction.
3. Carcinomatous infiltration which is not only annular in form but funnel-shaped.
4. Cauliflower masses surrounding the lumen of the esophagus
5. Papillomatous vegetations.

In the author's experience the most common forms are the first, second and the fourth. Syphilis may stimulate any of the five forms. The microscopic examination of a specimen combined with the therapeutic and the Wassermann test will rule out syphilis.

Cancer of the esophagus occurs oftenest at the upper or the lower end. It is not uncommon, however, to find it located about half way down the esophagus.

Symptoms of Cancer of the Esophagus.—The chief symptom of cancer of the esophagus is difficulty in swallowing. This symptom may be slight for years. Associated with the difficulty in swallowing, if the growth is located in the upper part of the esophagus, there is pain radiating to the ear of the affected side. Often the cervical glands are enlarged. They become infected even if the cancer is situated at the cardiac end of the esophagus. Later in the disease when the ingestion of food is impeded, emaciation sets in.

Diagnosis of Cancer of the Esophagus.—The old method of making a diagnosis of cancer of the esophagus was to label the difficulty in swallowing by some such name as globus hystericus, or neurasthenia, and to temporize until obstruction became marked and emaciation noticeable. Then a bougie was passed, an obstruction was found and the bougie brought up blood. Today this is antiquated surgery, to call it by no harder name. The bougie has cost many a patient his life not only by delaying the diagnosis until too late but also by perforating the weakened walls of the cancerous esophagus.

Diagnosis and Treatment of Cancer of the Esophagus.—Cancer of the esophagus is best diagnosed by the esophagoscope or by the open or tubular speculum. Palliative treatment is also best carried out through these instruments. The removal of a specimen for microscopic examination may seem a trivial affair in such an ugly disease, but the surgical satisfaction which comes from it is not to be despised.

If the cancer is well advanced and happens to be in the upper part of the esophagus the tubular speculum gives a splendid view and enables the surgeon to remove a generous specimen quickly and easily. Good biting forceps are necessary for this procedure, and care must be

Fig. 189.
Carcinoma of the esophagus

taken to pierce well into the tumor. (Fig. 189.) If the mucous membrane over the suspected area is unbroken it may be questioned whether or not it is justifiable to cut into it. Unless this is done, however, the

case must be left in doubt. If the examination is carried out under ether and the growth is situated at or near the mouth of the esophagus, the open speculum, given a favorable neck, affords a good view and enables the operator not only to remove a specimen but to clear away a great part of the fungating growth. In cancer below the mouth of the esophagus, if it is of the cauliflower type, careful curetting will

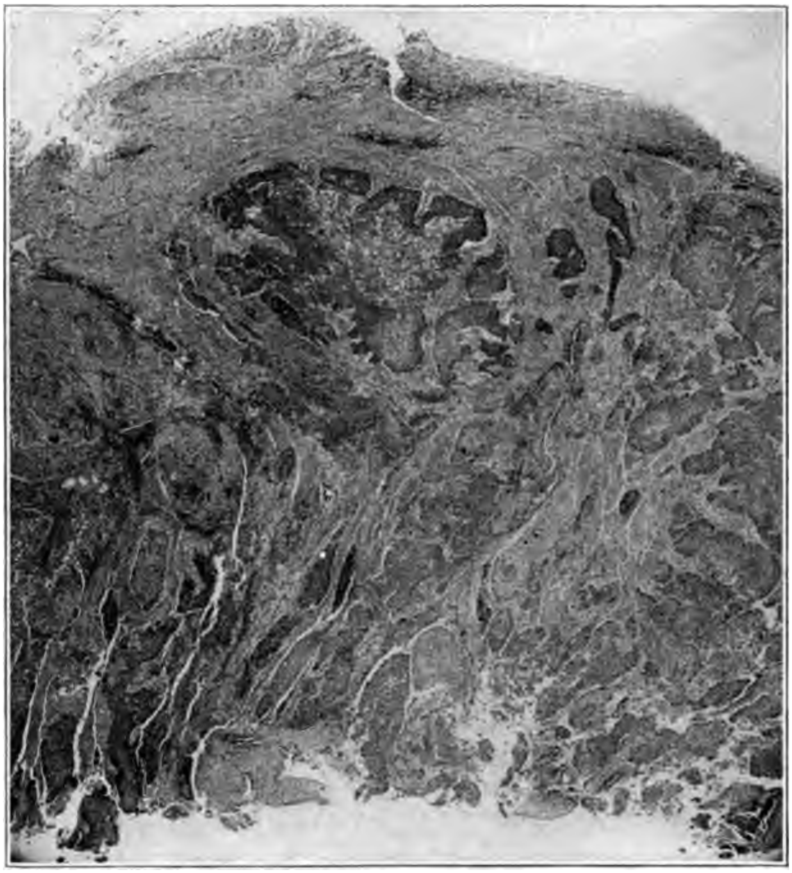


Fig. 190.
Section of carcinomatous area (low power). (See Fig. 189.)

remove the obstructing masses and restore the patient's ability to swallow soft food. The author believes from his results that this procedure is justifiable. The curetting may be repeated two or three times. (Figs. 190 and 191.) The examination of a case of cancer of the esophagus is not ideally complete unless the lumen of the cancerous stricture is ascertained and the presence of a secondary growth lower down is determined. (Figs. 192 and 193.) In order to accomplish this

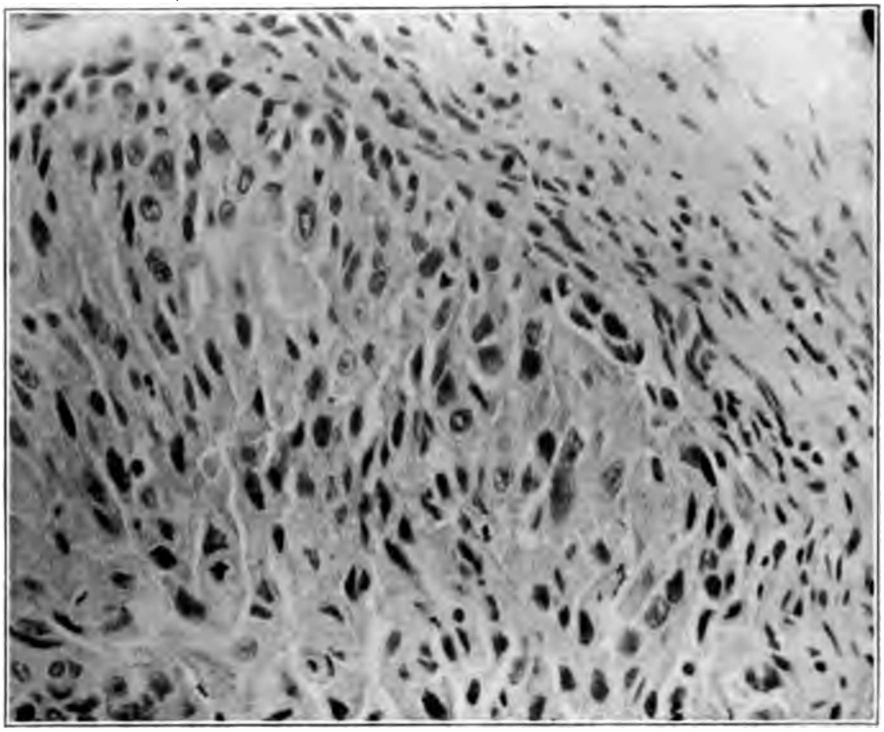


Fig. 191.
Section of carcinomatous area (High power). (See Fig. 190.)

Fig. 192.
Carcinomatous stricture of the esophagus.
(Plate by Dr. W. J. Dodd.)

a smaller tube should be passed through the larger esophagoscope and carried down through the rest of the esophagus. It is not always possible to do this, nevertheless the attempt should be made.

Fig. 193.

Cancer of the esophagus. Retouched tracing from X-ray plate. (Lateral view.) The esophagus is filled with bismuth gruel. At the point where the growth is the esophagus ends in an irregular cone. Splashes of bismuth which have passed through the stricture are seen below. (Author's case.)

When the walls of the esophagus are surrounded with fungating masses of cancerous growth it is hard to tell where the lumen of the esophagus is placed. In such a case if the esophagus is ballooned

with air the displacement of the cancerous masses reveals the site of the esophageal opening. If no opening is found but the air enters the stomach, pressure on the abdomen will force the air back and as it bubbles upwards through the structure the lumen can be located. In extensive disease of the esophagus the esophageal lumen can be saved for a time by intubing the carcinomatous stricture with a small elastic webbing funnel after the method of Mixter.

It is justifiable to dilate a cancerous stricture with bougies or with the mechanical dilator only by using these instruments through the esophagoscope and under visual guidance. Even with these safeguards the procedure must be employed with extreme care.

What every physician hopes to find in a case of cancer is that the new growth is located at the upper part of the esophagus, that it is not extensive and that it is of a low grade of malignancy. Such cases offer a chance of cure if the larynx is removed and the diseased portion of the esophagus resected. Patients who might have been saved by this method have gone to their graves without any attempt having been made to relieve them. Such cases exist today, but they will never be found except by the routine use of the esophagoscope. When hopeless cases are encountered, and they are still in the great majority, an early opening of the stomach will save the patient from starving to death. The author cannot understand the reluctance of some surgeons to giving the patient the benefit of this operation.

Compression Stenosis of the Esophagus.

Structures which border on the esophagus may push upon it and cause compression. The conditions which are commonly found to do this are glandular enlargements, cervical or mediastinal tumors, aneurism, plural effusions and spinal deformities.

The esophageal examination in these cases shows only a narrowed lumen. The general physical examination supplemented by an X-ray plate are the most efficient means of arriving at a correct diagnosis of the cause of the compression. In an aneurism the pulsations may be seen through the fluoroscope.

DISEASES OF THE ESOPHAGUS WHICH DO NOT CAUSE STENOSIS.

Inflammation and Ulceration of the Esophagus.

In acute inflammation of the esophagus the usual signs shown by an inflamed mucous membrane are present. According as the inflammation is general or local there is a small or an extensive area of reddening. Later the mucosa becomes edematous. The vessels of the mucosa

are not as a rule visible. Acute inflammation of the esophagus, if severe, is a contraindication to the passage of the esophagoscope. When, however, it is caused by the presence of a foreign body the inflammation should be disregarded and the foreign body removed at once. In acute inflammation where no cause is found, an underlying carcinoma should be suspected.

Chronic Inflammation of the Esophagus (Chronic Esophagitis.)—Chronic inflammation of the esophagus may follow acute inflammation but as a rule it is the result of the long continued irritation of pus or food. These are held in the esophagus by spastic or anatomic strictures, or by diverticula. Uncomplicated chronic catarrhal inflammation of the esophagus is seen most often in alcoholics. Here it is due chiefly to the irritation of the local irritant. The esophagus is usually a dirty gray or a pale red, at times mottled and with the vessels showing. Tenacious mucus covers it.

Ulceration of the Esophagus.—Ulceration of the esophagus occurs in two forms, ulcers located above the hiatus and ulcers below it.

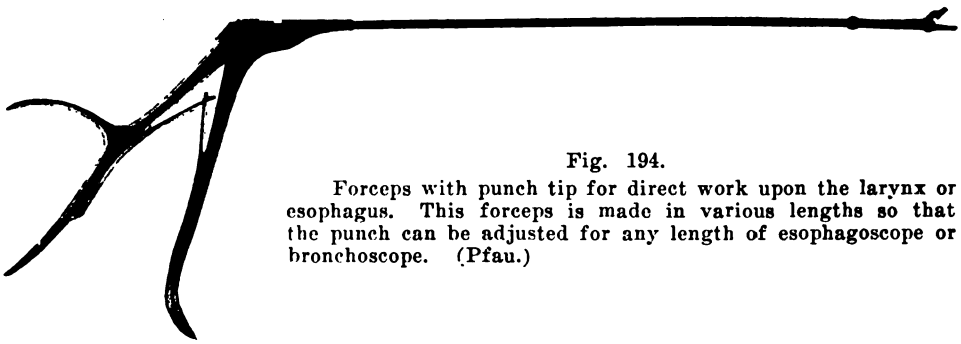


Fig. 194.
Forceps with punch tip for direct work upon the larynx or esophagus. This forceps is made in various lengths so that the punch can be adjusted for any length of esophagoscope or bronchoscope. (Pfau.)

Ulcerations above the hiatus may be due to any of the causes which produce acute inflammation of the esophagus, i. e., to infection or trauma. The ulcers occurring in typhoid fever are caused by thrombosis of the vessels. Deep painless ulcerations occur in syphilis. The same is true of the ulcerations which occur in tuberculosis. The greater part of the esophagus may be involved in tuberculosis without the lesion being suspected. Tuberculosis of the esophagus usually is secondary to tuberculosis of the lungs and is due to swallowing sputum. A tuberculous bronchial gland may ulcerate into the esophagus, though this happens but rarely.

Ulcerations of the esophagus below the hiatus bear a strong resemblance to peptic ulcerations of the stomach. They are often assigned to functional insufficiency of the cardia. Jackson believes that the closure of the upper end of the stomach is due to a kinking of the esophagus at the hiatus and that the kinking is caused by the pressure

of the contents of the stomach at the fundus and by the structures about the hiatus. The contents of the stomach, however, frequently invade the lower part of the esophagus. Ulcerations of the esophagus at this point have a resemblance to ulcerations of the duodenum and may have the same pathology. Codman has made the observation that duodenal ulcerations are often associated with fissures of the cardia. He made the further observation at autopsies that fissures of the cardia were not uncommon. The analogy is at once suggested between fissure of the cardia and fissure of the anus.

Where an ulceration cannot be explained the presence of a buried foreign body should be considered.

The treatment of ulceration of the esophagus consists first and chiefly in the removal of the cause. After this is accomplished the topical application of nitrate of silver, argyrol, or tannin is useful. The same procedure is advocated for the peptic ulcer. The ulcer is cleaned and then dusted with bismuth powder or touched with nitrate

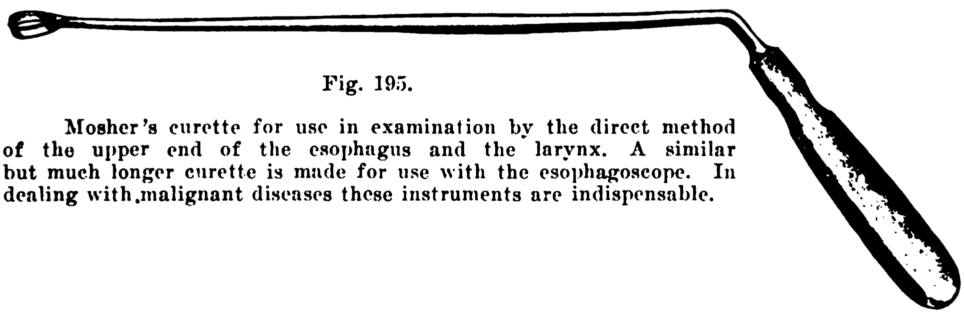


Fig. 195.

Mosher's curette for use in examination by the direct method of the upper end of the esophagus and the larynx. A similar but much longer curette is made for use with the esophagoscope. In dealing with malignant diseases these instruments are indispensable.

of silver. There is no danger of perforation or of hemorrhage if the manipulations are carried out gently, and always under clear vision.

Neuroses of the Esophagus.

Sensory Neuroses of the Esophagus.—The diagnosis of a sensory neurosis of the esophagus should be made with great care. Since the advent of the esophagoscope the number of true cases of sensory neuroses of the esophagus has been markedly diminished. A routine examination of such cases will reveal a large number of instances in which the symptoms have a real anatomic or pathologic basis. The old diagnosis of globus hystericus should never pass unquestioned. A trifling anatomic peculiarity like a partial band at the mouth of the esophagus, can readily cause these cases. The writer feels that further study of the upper end of the esophagus will show that such bands are frequent. Small ulcerations from trauma could cause such partial bands or adhesions. Whether caused by trauma or by some slight

irregularity of developments the passage of a good sized bougie under the old method of treatment would break the band and clear up the symptoms, but not the diagnosis. In order to make the diagnosis as certain as modern knowledge can make it the esophagoscope must be passed before the bougie.

True sensory neuroses include hyperesthesia of the esophagus, anesthesia, and paresthesia. The patient groups his symptoms under the head of a feeling of contraction of the upper part of the throat and difficulty in swallowing, or as a sensation of itching, pricking or general uneasiness. Except in cases of true hysteria sensory neurosis of the esophagus is very rare.

The appropriate treatment is along general medical lines.

Paralysis and Paresis of the Esophagus.—In cases where the innervation of the esophagus is interfered with, all solid food is swallowed with difficulty. Fluids are usually swallowed easily. At times, even fluids may go down with difficulty and only in small quantities. After eating there is pain back of the sternum and regurgitation of mucus or food.

Contrary to expectation the esophagoscope, even without ether, readily enters the esophagus and passes easily into the stomach. The ease with which it passes establishes the diagnosis, because in spastic stenosis spasm occurs if no anesthetic is used, and if there is an anatomical stricture this persists even under ether. The paralysis may be demonstrated by Stark's pill experiment. With the aid of the esophagoscope and forceps a pill or capsule is placed in the esophagus 27 cm. from the incisor teeth. If the peristalsis is normal the pill will be carried into the stomach; if the pill remains where it is placed a paralysis or an abnormal feebleness of the esophageal wall exists.

The chief causes of paralytic conditions of the esophagus are central nerve lesions, the most common being bulbar paralysis, and the neuritis which follows alcohol, diphtheria, and lead poisoning.

When a paralytic condition of the esophagus is suspected a neurologic examination is called for, and if such a condition is proved the treatment, of course, is along general lines.

Congenital Anomalies of the Esophagus.

Congenital anomalies of the esophagus occur occasionally. The esophagus may be bifid or double or it may end in a blind pouch. Children having these deformities seldom live for any length of time. Rarely, a fistula joins the trachea and the esophagus. Cases of this kind have been reported and the patients have survived. This was

possible for the reason that a valve-like fold of mucous membrane prevented food from getting into the trachea.

Congenital Stricture of the Esophagus.—A little girl about a year old was referred to the author with the history that she had swallowed a "pacifier," and had had almost complete obstruction to swallowing since the accident. The baby was very poorly nourished and it was found on questioning the parents that from birth she had continually thrown up her food. It was supposed naturally that the milk was not of the proper kind. Both the milk and the physician were repeatedly changed. The baby just managed to survive up to the time when it made a meal of the "pacifier." It speedily vomited the rubber nipple which was on the end of the "pacifier." Notwithstanding this it could not retain any milk. A local specialist passed an esophagoscope and through this introduced a bougie, but could not make it enter the stomach. At this point in the case the author saw the child. The X-ray showed a small round body apparently in the esophagus and at the level of the bifurcation of the trachea. This was supposed to be a bit of bone from the "pacifier." On examination under ether this bit of bone was neither seen nor felt, but instead a stricture was found. This was at the level of the bifurcation of the trachea and readily admitted a No. 16 F. bougie and was easily dilated up to No. 20 F. Subsequent dilatations carried the lumen of the stricture to 26 F. After a few days the baby began to retain milk. A second plate showed that the bit of bone which gave the round shadow in the first plate had disappeared after the examination. The stools were searched, but it was never found.

The following seems to be a reasonable explanation of this case. The child had a congenital stricture and she forced its discovery by swallowing the rubber nipple from the "pacifier" and perhaps a bit of bone from the handle. The first examination pushed the piece of bone through the stricture and the second pushed it into the stomach. The second examination determined the presence of the stricture and led to its dilatation.

Diverticulum.—A diverticulum is a pouch-like off-shoot from the esophagus. The so-called traction diverticulum is the easiest of explanation. It is caused by the contraction of scar tissue, arising from a suppurating gland in process of healing. This new tissue exerts a pull upon a circumscribed part of the esophageal wall and makes a pouch. In certain animals pouches and dilatations of the esophagus are normal; for instance, the crop and the dilatation of the lower portion of the esophagus in birds. Something of this tendency to variation in form may be retained in man. In one of the author's cases the

mouth of the esophagus was very wide as if the pharynx extended below the cricoid cartilage and had there attempted to make a double esophagus, the unsuccessful attempt being the pouch.

Diverticula are encountered most often in the upper part of the esophagus near the cricoid cartilage. In every esophageal examination the possibility of finding a pouch must be borne in mind and its existence ruled out.

Symptoms.—The symptoms of a small pouch are not marked enough to make the examiner do more than suspect its presence. The chief symptoms are slight difficulty in swallowing and soon after eating the regurgitation of a small amount of undigested or putrid food. Where a pouch has existed a long time and has dissected its way downward between the muscles of the neck and perhaps into the chest the symptoms, although of the same general character, are much more marked. It is impossible from the symptoms to differentiate such a case from one of phrenospasm and dilatation of the esophagus.

Diagnosis.—If the presence of a pouch is suspected the physician may give the patient bismuth and then take an X-ray; or he may give the patient bird shot to swallow and then take the plate; or he may pass a bougie. The bougie on its first introduction meets with an obstruction high up in the esophagus and then if it is withdrawn and reintroduced it enters the lumen of the esophagus and continues on into the stomach. No one of these three methods is as satisfactory as the diagnosis of a diverticulum by sight. An X-ray plate of an esophagus filled with bismuth often gives the impression of a pouch where none exists. This is due to spasm of the esophageal wall. Brünings has a beaked tubular speculum the lower half of which has a slit in the side. In using this the attempt is made to engage the beak of the speculum in the opening of the esophagus and after this has been located, to find the opening of the pouch by examining the esophageal wall through the slit in the side of the instrument.

In the search for diverticula the ballooning attachment for the oval esophagoscope is of the greatest service. There is usually no trouble in finding the pouch, as the esophagoscope goes into it most readily. Once in the pouch, the examiner sees no esophageal lumen ahead. Instead there is an unbroken wall. On attempting to readjust the long axis of the tube to conform to the long axis of the esophagus still no lumen appears. If now the window plug is inserted and the pouch distended with air the fact that the end of the esophagoscope is in a closed cavity becomes clear. Not only this, but the size of the pouch can be made out and the condition of its walls. The bottom of the pouch is found in many cases to be thickened and inflamed from the

retention and maceration of food. When the pouch has been outlined in this way if the esophagoscope is slowly withdrawn, and all the while air is forced into the pouch, at the moment when the end of the esophagoscope leaves the mouth of the pouch and is opposite the opening of the esophagus two openings will be seen through the tube. The new opening will prove on examination to be the lost opening of the esophagus. This is by far the best method of determining the presence of a diverticulum.

Treatment of Esophageal Diverticula.—If the pouch is large enough and not too large, that is, if it does not extend into the chest, it may be dissected out. This is the treatment advocated at the Mayo Hospital. Small and medium sized pouches may be cured symptomatically by dilating the esophagus at the point where the pouch leaves it. This is done by first finding the pouch and cleaning it of food and then stretching the esophagus with the mechanical dilator. After this a thread is passed through the esophagus into the stomach and allowed to engage in the upper part of the intestinal tract. As soon after the ether examination as the thread has become well anchored, the metal staff of Mixter with its perforated olive is carried down on the thread and olives of increasing size are forced down on the staff. After a week or two the metal staff will find the esophageal opening unguided by the thread and the thread may be allowed to pass on. The physician soon finds that he can pass elastic bougies also of increasing size, through the esophagus. Lastly the patient is taught to pass a bougie of reasonable size for himself. This has to be continued for an indefinite time. Mixter, who has had much experience both with excision of the pouch and with the symptomatic cure by dilatation, favors for the general run of cases the treatment by dilatation.

Some day it may seem feasible to cut the common wall between a small pouch and the esophagus. When this procedure is attempted it will be carried out if it is to be performed in a surgical fashion, through the esophagoscope. The writer tried this in a rather hesitating manner on one case, and is waiting for an appropriate case to try it again. The results were mediocre, i. e., no better than dilatation.

Dilatation of the Esophagus.

In dilatation of the esophagus the whole structure becomes enlarged and acts as a sac instead of a tube. The most common form is a spindle-shaped esophagus. From certain observations the author is of the opinion that a dilatation of moderate degree of the

lower third of the esophagus is common, if not normal. It is certainly not unusual in dissecting room bodies.

The lower part of the esophagus is the part most often enlarged. The dilatation is due either to an anatomic stricture or to a spastic closure at some point. The forms of stricture have been discussed. Spastic closure, as has been said, is due as a rule to spasm of the hiatus of the esophagus or to spasm of the cardia. Dilatation of the esophagus is spoken of at this point under a separate heading, and after diverticula of the esophagus have been discussed, because the two conditions have to be differentiated.

The diagnosis is made by examining the lumen of the esophagus through the esophagoscope. In the normal esophagus the wells hug the examining tube and are seen to be continuous with the end of the tube for some distance ahead. If the esophagus is dilated the end of the esophagoscope finds itself in a large, dark cavern, the walls of which become clear only as the tube is moved strongly from side to side. The opening of the esophagus below the dilatation may not be in the center of the dilated portion, but eccentric. Not only this, but the dilated portion may sag below the level of the esophageal opening and make a deep moat about it. Most often the sagging of the dilated part of the esophagus below the opening of the esophagus occurs to the right of the esophageal opening. It is into this sagging part of the esophagus that the point of the examining bougie invariably finds its way, and it is at this point that perforation of the esophagus from rough manipulation with bougies occurs most frequently. When this pouch-like collar occurs at the lower end of the esophagus the use of a metal staff with an olive on the end enables the examiner to swing the point of the olive to the left and to fish successfully for the opening of the esophagus. Ballooning the esophagus smooths the folds and makes the lumen stand out clearly.

The treatment of dilatation of the esophagus is to treat the condition which causes it. This has already been given.

Foreign Bodies in the Esophagus.

Jackson begins his chapter on foreign bodies in the esophagus with the following sentences: "Considering the brilliant achievements of esophagoscopy in the removal of foreign bodies from the esophagus, it is time to pronounce the prevalent use of the sound, the vertebrated forceps, the coin catcher, the bristle and sponge probangs obsolete, dangerous, unsurgical and utterly unjustifiable. There are numerous cases on record of fatal results from their use, and there are many times as many cases that have never been reported." This language

is none too strong, especially when applied to the use of these instruments in cases of rough or sharp foreign bodies.

Foreign bodies lodged in the esophagus fall naturally into two groups, smooth foreign bodies and rough or pointed ones. In the first class are penny whistles, buttons and coins. Prominent in the second are pins, needles and safety pins, fish bones, chicken bones, meat bones and, lastly, partial or complete tooth plates. Coins often lodge for a while and then go down, although there are many cases in which coins have failed to pass into the stomach but have remained in one position and ulcerated into the aorta or trachea. Pointed and sharp objects as a rule lodge and finally perforate and generally prove fatal.

Ordinarily patients come to the physician with the history that they have swallowed a foreign body. This is not always the case, however, because it sometimes happens that they come simply for difficulty in swallowing. In infants regurgitation of food may be the only symptom. Older children may swallow liquids but not solid food and there is a persistent cough. Patients often think that a sharp foreign body is still in the esophagus when in reality it has passed downward. The scratch or abrasion caused by it, and this is especially true of fish bones, for some days makes the patient feel that something is wrong and he interprets his abnormal sensations as the continued presence of the foreign body. Without an esophageal examination it is very hard to disabuse the patient of this idea. Patients seldom localize the position of the foreign body accurately.

Places Where the Foreign Bodies Lodge.—Foreign bodies in the esophagus lodge most often back of the cricoid cartilage. If they are dislodged from here they stop again at the level of the inner end of the clavicles. Anatomic narrowing is said to be responsible for this. Once beyond the clavicles smooth foreign bodies almost always find their way into the stomach and any smooth foreign body which gains the stomach as a rule can pass the pylorus. It is astonishing how large an object can do this. The author has known a flat, mother-of-pearl button one inch in diameter to pass from the stomach of a one-year-old child into the intestinal tract and to be recovered in the stools in twenty-four hours.

Procedure to be Followed in Cases of Foreign Bodies.—The history of the case is taken and the parents or the friends of the patient are instructed to bring a duplicate of the foreign body if it happens to be a nail, a pin, or a button. The physician can probably furnish a duplicate if the foreign body is a coin. Unless the case happens to be desperate from pressure upon the trachea an X-ray plate is taken.

This determines the position of the foreign body and in case its nature is not known often discloses it. Next, appropriate instruments for the extraction of the foreign body are selected or obtained. Success in the removal of foreign bodies lodged either in the trachea or in the esophagus depends upon two things, the mechanical sense and dexterity of the operator, and suitable instruments. In the matter of instruments it is vitally important to select grasping forceps with blades adapted to seizing the particular foreign body in hand. (Fig. 196.) On the duplicate foreign body the forceps chosen can be tested. If the duplicate foreign body is placed in a piece of rubber tubing the manipulations necessary for its extraction can be practiced. Such practice leads to sureness and confidence and these in turn lead to success.

Before using the tubular speculum or the esophagoscope a systematic examination is made with head-light and mirror of the patient's mouth and pharynx. The crypts of the tonsils, the supratonsillar fossa

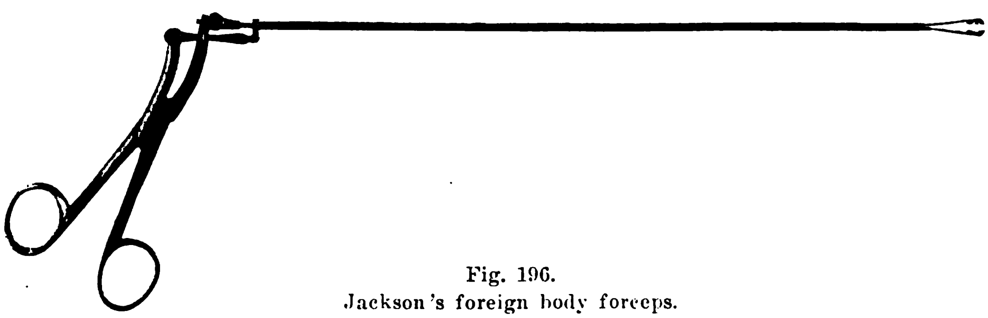


Fig. 196.
Jackson's foreign body forceps.

and the valleculæ at the base of the tongue and the pyriform sinuses are examined in turn. Impacted concretions in the supratonsillar fossa often give the sensation of a foreign body. If a good view cannot be obtained after cocainization and if the foreign body happens to be small like a fish bone or a pin, the base of the tongue and the pyriform sinuses are explored with the tip of the finger. Should the foreign body happen to be a coin this manipulation is not employed for fear that the gagging caused by it might dislodge the coin from the grasp of the mouth of the esophagus and start it downward. For the same reason sounds and bougies are not passed.

Choice of the Anesthetic.—After the examination of the mouth and pharynx has proved negative the operator decides whether the examination with the tubular speculum is to be carried out under local or general anesthesia. Many successful extractions of foreign bodies, notably in the German clinics, have been performed under local anesthesia. Even partial tooth plates have been so removed. Some allowance must be made for the temperament of the patient

and also for the temperament of the operator. The author has repeatedly expressed his individual preference for general anesthesia. If the operator prefers the sitting position and cocain anesthesia, well and good, provided that the results are good; if, on the other hand, he should prefer general anesthesia and the prone position of the patient he should not be ruled out of court.

Coins and Buttons in the Esophagus.—Coins and buttons and for-

Fig. 197.

Penny lodged in the upper part of the esophagus of a child. The penny is well above the level of the clavicles, that is, it is just below the mouth of the esophagus and opposite the cricoid cartilage. (X-ray tracing retouched and reduced. Drawing made by the author. From the throat clinic of the Massachusetts General Hospital.)

eign bodies of similar form usually lodge behind the cricoid cartilage. These cases usually occur in children. The first thing which the physician should remember when he encounters such a patient is to keep his finger out of the child's mouth. (Fig. 197.) If the X-ray plate shows that the coin is sticking behind the cricoid cartilage and the patient is an infant or a young child, it is wrapped in a blanket, placed on its *back on the* examining table and the head is brought over the end of

the table and held by an assistant. If the child is too large to be controlled, ether is given. The operator has a choice of instruments for bringing the coin into view, the closed tubular speculum of Jackson or Brünings and the adjustable speculum of the author. If the adjustable speculum is selected the point of the speculum is passed under its own illumination or under the illumination of the head mirror—and no illumination equals that of the head mirror for short distances—until the point of the speculum is engaged behind the ring of the cricoid cartilage. When the cricoid cartilage is held forward it is possible to see down the lumen of the esophagus almost to the level of the clavicles. Coins and buttons lie flat against the vertebral column, so that the operator sees only the upper edge of the rim of the coin. This appears as a dark, transverse line. The edge of the coin being in view it is a simple procedure to pass a pair of angular forceps and remove it. The tubular speculum can be employed in the same way. It does not, however, give such a wide field for operating as the adjustable speculum. If the coin is below the reach of the speculum an esophagoscope of appropriate size is introduced into the esophagus and carried down carefully until the foreign body comes into view. As large a tube should be used as possible, because it is humiliating yet true, that a small bronchoscope may pass a coin without the examiner seeing it, or detecting it by striking it with the end of the tube. A manipulation which will occasionally bring the coin to view is to elevate the handle of the tube strongly and to press the point against the vertebral column. This saved the author on one occasion from the embarrassment of defeat in the case of the child of a physician. When a button or a coin is lodged in the thoracic portion of the esophagus as the examining tube approaches it the lumen of the esophagus changes from the customary rosette to a transverse slit. In this dark transverse slit the foreign body is lodged and is holding the esophageal walls apart. The first grasp of the forceps upon the coin should be a sure one, because if the coin is nibbled and not firmly seized, the operator may have the mortification of seeing it disappear down the esophagus. If he catches sight of it again he is fortunate; generally it has gone into the stomach. If before or during the examination the patient vomits, examine the vomitus. The foreign body may be found in this. (Fig. 198.)

The Bristle Probang.—The use of the bristle probang is allowable only in case a bolus of meat or a smooth foreign body like a coin or a button is lodged behind the cricoid cartilage. Its use in such cases is often successful and is without danger. A more surgical procedure, however, is to use the speculum. When rough foreign bodies like fish or chicken bones or pins are to be dealt with the use of the bristle

probang is contraindicated. In the rare cases in which the use of the tubular speculum or the esophagoscope fails to disclose the foreign body the bristle probang comes again to its own. If a coin or a button cannot be found and extracted it is a good practice, at least from the standpoint of the patient, to push it down. Opening the side of the neck for the removal of a smooth foreign body of this nature is obsolete surgery.

Pins in the Esophagus.—When a pin is lodged in the esophagus, especially when its point is turned downward, it does not as a rule

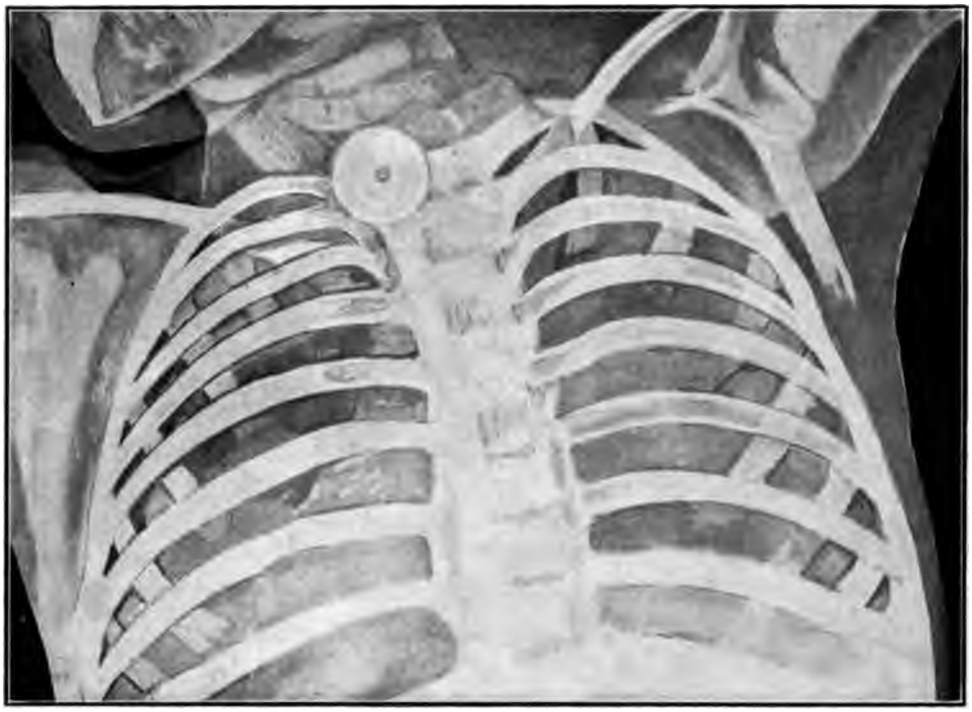


Fig. 198.

Penny whistle in the upper part of the esophagus of a seven year old child. The whistle lodged just below the mouth of the esophagus and behind the cricoid cartilage. This is the favorite place for foreign bodies to halt. The whistle was removed under ether with the author's open speculum and angular forceps. Such cases are best managed with the tubular or the open speculum. (Author's case. X-ray tracing retouched and reduced. Massachusetts Charitable Eye and Ear Infirmary.)

give much trouble in the extraction. When, on the other hand, the point of the pin is uppermost and embedded, its removal may be very difficult. Casselberry's pin cutter which divides the pin and holds the fragments is practically indispensable for the proper management of such cases.

Safety Pins in the Esophagus.—(Fig. 199.) An open safety pin, point up, is one of the hardest of foreign bodies to remove from the esophagus. The aim of the operator is to close the pin. This accomplished, the extraction is easy. Coolidge, some eight years ago, was the first to remove a safety pin from the esophagus. He used a safety pin closer devised by the author. Since the time of this case other methods have been devised for successfully closing a safety pin. Within the last year Jackson has introduced a daring and simple method of closing and extracting a safety pin. (Figs. 200 and 201.) Through the esophagoscope with forceps tipped with two slender interlocking blades he grasps the ring of the pin. When the blades of the forceps are

Fig. 199.

Safety pin in the esophagus. Child two years old. Author's case. Extraction by means of the esophagoscope failed and the pin was pushed into the stomach and removed by incision. The child died of pneumonia. (Plate by Dr. W. J. Dodd.)

locked in the ring, the pin is carried into the stomach and allowed to turn. Then the forceps are withdrawn with the pin headed the other way. As the pin comes into the tube it closes. The author has devised a safety pin tube the aim of which is to close the pin and to extract it without first pushing it into the stomach.

A few years ago the author originated an instrument (Fig. 202) for closing an open safety pin, point up. The device consisted of a double bronchoscope, one tube being placed within the other. The outer tube had a slit in the side which engaged the pointed shaft of the pin. Rotation of the inner tube closed the pin. The device has been simplified by discarding the inner tube. The present instrument is

made as follows: It is the usual self-lighted bronchoscope. There are two sizes, the smaller one for the trachea and the larger one for the esophagus. The end of the tube is bevelled on the side. From the apex of the V a slit runs upward about two inches. At the summit and at the side of this there is a second smaller and connecting slit. A pointed tongue separates the two slits.

Suppose for the sake of illustration that the point of the pin is up, and imbedded in the right esophageal wall. The tube is used in the

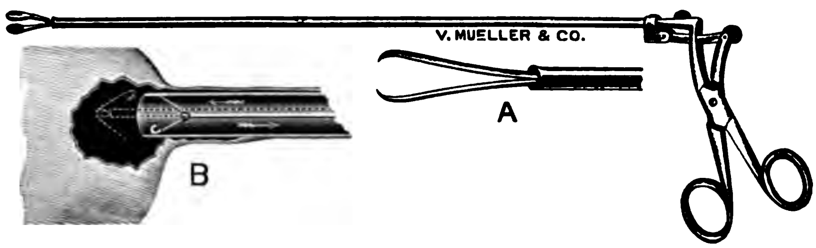


Fig. 200.

Jackson's forceps for grasping and pushing open safety pins into the stomach for turning. A, illustrates point of forceps; B, illustrates method of procedure.

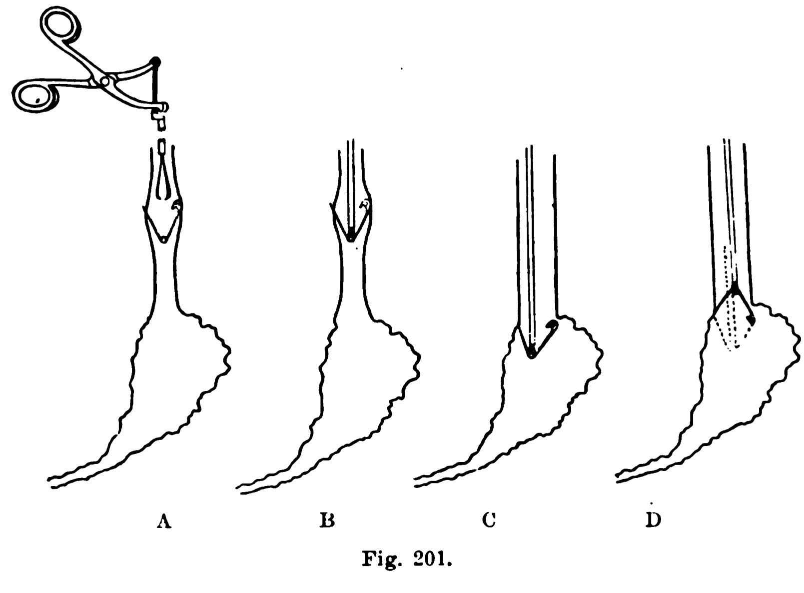


Fig. 201.

Schema showing Jackson's method of removing an open safety pin from the esophagus by passing it into the stomach, where it is turned and removed. The first illustration (A) shows forceps before seizing pin by the rings of the spring end. (Forceps jaws are shown opening in the wrong plane.) At B is shown the pin seized at the ring by the forceps. At C is shown the pin carried into the stomach and about to be rotated by withdrawal. D, the withdrawal of the pin into the esophagoscope which will thereby close it. (From the Laryngoscope.)

following manner: It is carried into the esophagus until the hood of the pin can be seen. This is grasped with forceps and steadied while the slit is turned so that it engages the pointed shaft of the pin. Then the tube is pushed onward until the top of the slit brings up against the crotch of the safety pin. This stage of the manipulations reached the tube is carried a little further down in order to free the point of the pin from the esophageal wall. This accomplished the hood of the pin is again held motionless by the forceps while the barrel of the tube is rotated to the right. By this manipulation the shaft which bears the point of the pin is made to lie in line with the accessory slit. The pin is now pushed straight down the tube. As it descends the accessory slit, which of course is closed below, acts as a ring and shuts the pin.

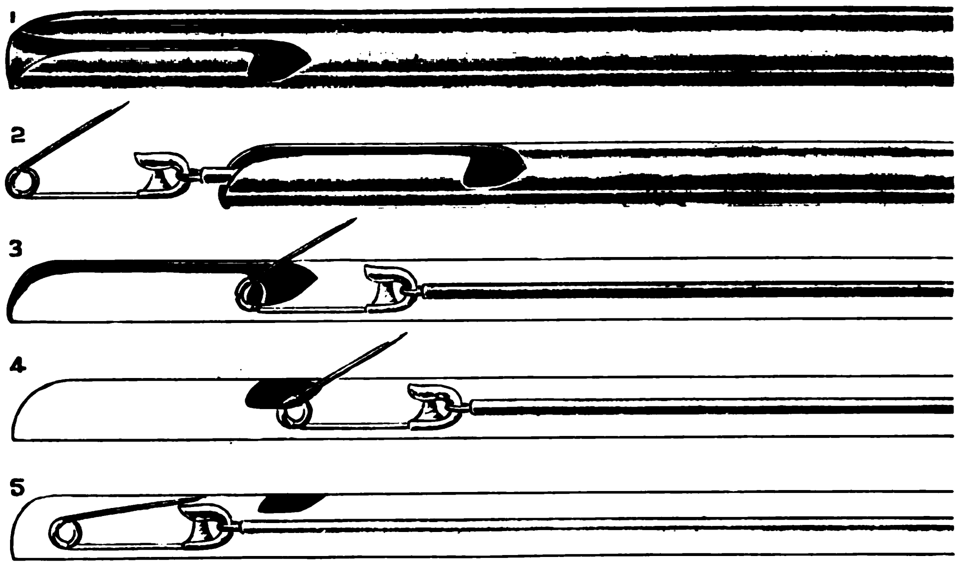


Fig. 202.

Mosher's safety pin removing tube. 1, end of safety pin closing tube. 2, hood of pin grasped through tube. 3, tube carried down until main slit brings up against the crotch of pin. 4, barrel of tube rotated to the right in order to bring pin in line with secondary slot. 5, pin pushed down and closed.

The tube and the pin are withdrawn together. A moment's practice outside of the body will show that these manipulations which seem complicated when described are in reality very simple.

Hubbard has devised a useful loop guide for the wire snare, and employed it successfully for the closing and removal of a safety pin.

Tooth Plates in the Esophagus.—Tooth plates, especially partial plates with prongs, have the unpleasant distinction of being the hardest foreign bodies which the physician is called upon to remove from the esophagus. Many successful extractions of tooth plates, however, have

been recorded. (Fig. 204.) It is an axiom in dealing with these difficult cases that unless the extraction is fairly easy and is soon accomplished the foreign body should be removed by an incision through the side

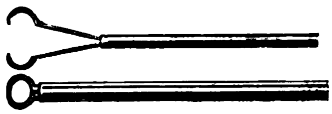
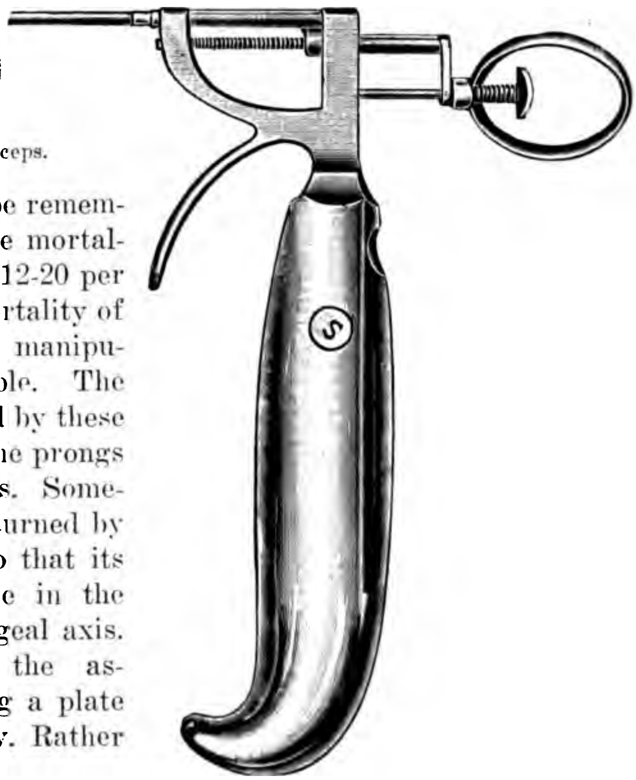


Fig. 203.
Mosher's safety pin forceps.



of the neck. It should be remembered, however, that the mortality of this procedure is 12-20 per cent or ten times the mortality of esophagoscopy. Rough manipulation is not permissible. The chief difficulty presented by these cases is the locking of the prongs of the plate in the tissues. Sometimes the plate can be turned by careful manipulation so that its short diameter may lie in the direction of the esophageal axis. Killian accomplished the astounding feat of cutting a plate in two by galvanocautery. Rather

Fig. 204.
Tooth plate in the esophagus. (Plate by Dr. W. J. Dodd.)

than attempt to turn the plate it is better surgery, unless the turning should prove to be easy, to cut the plate. For this a powerful forceps is necessary. A cutting forceps has been devised by Kahler. The one devised by the author is illustrated in Fig. 205.

The tooth plate should be attacked early, before the irritation set up by it has caused the esophageal wall to become inflamed and edematous. When this has occurred it is hard to get a good view. Brünings has invented a dilating esophagoscope for use in these cases.

After all esophageal examinations, and especially after the manipulations necessary for the dilatation of a stricture, or for the removal of a foreign body, the patient complains of a sore throat. Sometimes this is severe and makes the swallowing of food difficult for a few days. After the stretching of a stricture there may be pain along the course of the esophagus and sharp pain in the epigastrium. Also there may be a rise of temperature for twenty-four hours. Now and then there is emphysema of the side of the neck. These unpleasant symptoms, which, put in perspective, must be regarded as trivial, soon disappear under simple treatment.

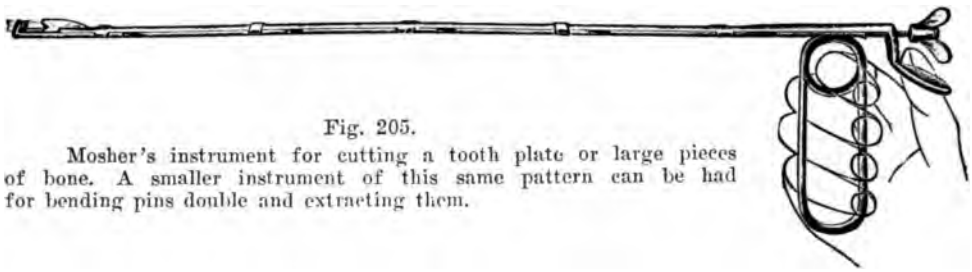


Fig. 205.
Mosher's instrument for cutting a tooth plate or large pieces of bone. A smaller instrument of this same pattern can be had for bending pins double and extracting them.

GASTROSCOPY.

History.—In 1881 Mikulicz, who did so much pioneer work in esophagoscopy, decided after experimentation that the gastroscope must be rigid. The men who had attacked the problem of gastroscopy before this time had used instruments which were jointed. Mikulicz, however, placed a bend in his gastroscope in order that it might accommodate itself to the curve of the vertebral column. His instrument was closed and the picture of the gastric mucosa was produced by prisms after the fashion of the cystoscope. Rosenheim also worked with a rigid tube but he discarded the bend. In the construction of his tube he also made use of lenses and prisms. It remained for Jackson, using a straight instrument without optic apparatus, to make gastroscopy feasible and comparatively easy. He elongated the esophagoscope of Einhorn and added a drainage tube on the side. He demonstrated that such an instrument could be passed into the stomach readily, and laid down the axioms of modern gastroscopy, namely: The gastroscope must be passed by sight. The stomach should be examined in the collapsed state to permit cleaning of the mucosa by mopping, and to enable the operator to palpate the walls of the stomach with the end of the instrument. General anesthesia is indispensable in order to present retching. When this occurs the diaphragm clutches the tube and defeats the examination.

Usefulness of Gastroscopy.—Modern gastroscopy after the method of Jackson is a relatively new procedure, so that the part it is to

play in surgery has not yet been determined. All endeavor in this line is still pioneer work. When the physician in making a diagnosis is able to substitute sight for touch he has made a gain almost too great to measure. Gastroscopy by the Jackson method has actually done this. It follows, therefore, that it is of the greatest service in determining the presence of cancer and in locating ulcers. By this method it is possible also to remove certain foreign bodies from the stomach.

The cry of the surgical world in cases of cancer is, "Make the diagnosis early." When cancer of the stomach is suspected let the surgeon therefore turn to the gastroscope.

Instruments.—The gastroscope of Jackson is a long esophagoscope. (Fig. 206.) Frequently in order to examine the stomach the tube must be 80 cm. in length. For many cases, however, 70 cm. is sufficient. Such a tube can be lighted satisfactorily only in one way, that is, by a light at the far end. This means that the tube must be of the self-lighted pattern. The diameter of the adult tube is 10 mm. Jackson states that he frequently uses a tube whose outside dimensions are 11 mm. in one diameter and 14 in the other. The distal end of the tube is

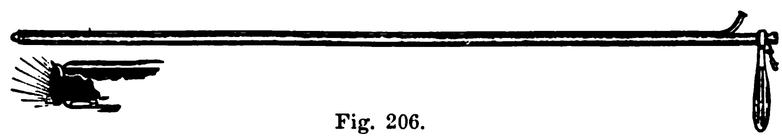


Fig. 206.
Jackson's bronchoscope, esophagoscope and gastroscope.

made in the form of a thickened ring in order to prevent injury of the tissues. The tube is fitted with an obturator the conical end of which projects beyond the gastroscope and makes the introduction easier. An elastic bougie somewhat longer than the gastroscope can be employed instead of the obturator.

The Technic of Gastroscopy.—General anesthesia is essential for the proper performance of gastroscopy and deep anesthesia is necessary to prevent retching and to relax the fibres of the diaphragm at the point where the esophagus passes through it.

The patient is given the usual surgical preparation. Food is withheld for twelve hours in order that the stomach may be as empty as possible. Washing out the stomach is not a satisfactory substitute for fasting.

The Position of the Patient.—Jackson in his earlier work had the patient placed on his back and in a position half way between the Trendelenburg and the horizontal posture. This causes the fluid remaining in the stomach, and it is never possible to get the stomach completely dry except by mopping through the gastroscope, to drain from the stomach by gravity. Of late Jackson has elevated the head of the table

after the introduction of the tube so that the operator can examine at his ease. In the final position, the head of the table is about 30 cm. higher than the foot. The assistants are placed as in bronchoscopy or esophagoscopy. The second assistant holds the head. This is a very responsible position. Boyce, who has long assisted Jackson, has given much study to this detail of the examination. The following statement of the method in which the second assistant should manage the head is taken from a detailed description given by Boyce. The mouth. pharynx and esophagus are brought into a straight line, not by the leverage of the tube, but by the position of the patient's head. The head is held steadily in extreme extension and the mouth is kept wide open. The jaws are kept apart by a gag placed in the left corner of the mouth. The assistant who holds the head also keeps the gag in place.

The patient is drawn toward the operator until his shoulders are clear of the operating table by four or six inches. The gag is inserted on the left side. The assistant sits on the right of the patient on a stool. His right leg is held in the kneeling position while the left foot is supported on a stool 26 inches lower than the top of the table. The assistant's right forearm is passed beneath the neck of the patient and supports it. The right hand grasps the mouth gag and keeps it from slipping. The left hand of the assistant rests on his left knee and grasps the top of the patient's head and at the same time bends it backward and upward. The exact amount of backward bend and of upward pressure required is determined by experience on the individual case.

Passing the Gastroscope.—The gastroscope should be passed gently. If the tube does not advance readily its position is wrong and it should be changed. The tube must be well lubricated with vaselin. The gastroscope is grasped and held by the right hand of the operator after the manner shown in Fig. 207 (Jackson).

The forefinger of the physician's left hand is introduced into the right pyriform fossa of the patient and the end of the gastroscope is carried down with the finger as a guide. As the tube descends a certain amount of upward leverage is made with it on the base of the tongue and the epiglottis and finally on the cricoid cartilage. The finger of the physician can seldom feel the cricoid cartilage in the adult. This is immaterial because once the end of the gastroscope is well inserted in the right pyriform sinus it drops readily into the esophagus, provided there is no disease at this point. Disease at the beginning of the esophagus should have been excluded previously by the use of the laryngeal mirror. If this has not been done it is excluded at the time by examination with the speculum. It is seldom necessary to pass a flexible bougie through the tube and into the esophagus to serve as a guide.

After the tube has slipped into the esophagus the head of the patient is raised slightly, the obturator is withdrawn and the current for lighting is turned on. From now on the tube is passed by sight. The esophageal lumen must be made out ahead of the tube before it is advanced. With each inspiration the esophagus opens and guides the tube in the right direction. The end of the gastroscope is kept in the long axis of the esophagus, and not pointed strongly upward for fear of collapsing the trachea. After the introitus has been passed only two points give trouble. The first is the hiatus of the diaphragm, the second the subphrenic portion of the esophagus. The hiatus is passed by making the long axis of the elliptical tube correspond with the long axis of the hiatus. The axis of the hiatus, as has been said, is oblique from behind forward and from right to left. It helps very much if the hiatus is partially or fully closed as the tube approaches it. If it is, the

Fig. 207.

Position of the right hand during the introduction of the gastroscope, viewed from above by the operator looking downward. (After Jackson.)

observer sees a central rosette-like opening ahead of the tube. The esophagus leading down to this is smooth. (Fig. 169.) The end of the tube is placed against this opening and then a little pressure or a little deepening of the anesthesia allows the tube to slip through into the abdominal portion of the esophagus. The picture seen through the tube at once changes. Instead of smooth walls as before, the esophagus is now thrown into long, thick folds which center at the left of the field. (Fig. 170.) No regular opening is made out, but if the end of the tube is crowded to the left and advanced slowly the folds part and the irregular dark slit suddenly bursts open and the tube is in the stomach. If the cardiac opening of the esophagus is in a state of spasm the long longitudinal folds of the abdominal esophagus swing from left to right and radiate from a small circular opening which is placed in the left quadrant of the field.

In order to pass the abdominal esophagus it is necessary sometimes to bend the head and neck of the patient to the right. Full anesthesia is necessary for passing the hiatus, the subphrenic portion of the esophagus and the cardiac opening.

When the gastroscope has entered the stomach it is necessary, owing to the small field given by the tube, to have a system in the examination. There are two plans of exploration. First the gastroscope is carried straight down to the greater curvature, inspecting on the way a strip of the anterior and the posterior walls. If the stomach is not sufficiently collapsed one wall must be taken at a time. After the first strip has been gone over the end of the tube is moved slightly to one side and brought up and a new set of folds examined. This is repeated until the pyloric limit is reached.

As much of the stomach as possible is examined strip by strip. Then the second method of examination is practiced. This consists in passing the tube down to the extreme left of the greater curvature and then swinging it along the line of the greater curvature to the right. Having reached the right limit the tube is withdrawn a little and swung back like a pendulum. In this way, retreating step by step and swinging the end of the tube back and forth from right to left, the examination is continued until the cardia is reached. The examination is greatly aided by having an assistant manipulate by palpation the unexplored portions of the stomach in front of the end of the tube. For this purpose the patient may be turned first on one side and then on the other. During these manipulations the tube is withdrawn into the esophagus and then pushed into the stomach again when the new position of the patient has been adjusted. If the patient begins to retch when the tube is in the stomach it is withdrawn into the esophagus above the diaphragm.

The vertical diameter of the stomach is determined by measurement. The distance from the teeth to the cardia is ascertained and then the gastroscope is pushed down to the greater curvature and the distance from the teeth determined again. The difference between the two measurements is the vertical diameter of the stomach. In these manipulations it is necessary to avoid pushing the greater curvature downward.

The smallest vertical diameter found by Jackson in an adult was 4 cm. (one and one-half inches) and the greatest 36 cm. (fourteen inches).

The end of the tube tends to drag the stomach walls along with it. This can be avoided by withdrawing the tube a little and then carrying it down again. The average time required to examine the stomach is thirty minutes.

The Area of the Stomach Which Can Be Explored.—Vertical and infantile stomachs afford the greatest range of exploration. The more horizontal the stomach the less the range. The lateral movement of the hiatus makes it possible to examine the stomach over an extended area. This lateral movement varies with the individual. It is greatest in feeble, elderly and emaciated patients. Also the deeper the anesthesia the greater it is. The anteroposterior mobility of the hiatus is of but little use. If the diaphragm were rigid gastroscopy would be much limited. Owing to its flexibility the end of the tube can be made to pass at the hiatus through an ellipse the small diameter of which is 5 cm. and the large diameter 15 cm. The long axis of this ellipse is placed laterally.

The full range of the thoracic aperature is made available by shifting the head and the neck to the side. The pivotal or rocking point of the gastroscope is in the thorax not at the beginning of the esophagus or at the hiatus.

As a rule the tube can be made to point in turn to either superior spine of the ilium and the greater curvature can be forced down to this level.

Any anomaly or disease of the esophagus may render gastroscopy difficult or impossible.

Contraindications.—The contraindications to gastroscopy are the usual conditions which make the giving of an anesthetic unsafe.

Dangers.—The dangers of gastroscopy in careful hands are only the risks of the anesthesia. The observations of Boyce show that the blood pressure falls when a rigid tube is introduced into the esophagus. This, however, lasts only a short time. As esophagoscopy and gastroscopy are done by sight there is less danger than in the passing of a sound.

Difficulties.—Any physician who has had a training in the use of the microscope can look through the gastroscope and see the picture which it presents. If he has not had this training it takes a little time for him to teach his eye to see.

Lordosis, Potts' disease and other diseases of the spine make gastroscopy impossible.

The Stomach as Seen Through the Gastroscope.

The Normal Stomach.—The folds of the stomach are constantly changing so that no two views are alike. When the gastroscope enters the cardiac opening the folds extend straight on from the mouth of the tube and a small tunnel of open stomach is seen. As the tube is carried down through this the folds take a lateral bend. Finally, the tube brings up against the stomach wall. This appears as a flat surface

which is sometimes mottled, sometimes slightly red. The greater curvature allows the tube to push it downward some 10 cm. before it resists. When the tube is withdrawn the stomach wall, which has been flattened against it follows the tube upward to the position where the tube first encountered it or a little higher. As yet not enough is known about the arrangement of the folds to attempt to group them.

The mucosa of the esophagus and that of the stomach at times are strongly contrasted in color. The color of the esophagus, however, is more constant. The esophagus is generally a pale pink whereas the mucosa of the stomach varies from a similar pink to a deep crimson. Jackson considers that the color of the empty stomach varies from a pale red to a pale pink. The mucosa appears moist and glistening but less transparent than the mucosa of the esophagus. In the walls of the empty stomach vessels are not usually visible.

The pylorus is, of course, found on the right extremity of the greater curvature. As the tube approaches the folds guarding it, it seems like a slit. This gives way when the tube has fully reached the opening, and a round opening appears somewhat like the rosette made by the esophagus at the hiatus. The observer makes sure that the opening is the pylorus by advancing the tube into it until the small annular folds of the duodenum come into view. If bile colored fluid escapes upward at this point the localization of the pyloric opening is determined beyond a doubt.

The Movements of the Stomach.—Beside the ordinary peristaltic movements of the stomach there are movements associated with the heart and with respiration.

The movements transmitted from the heart are best seen just as the tube enters the cardia. They come from the heart and the descending aorta and are synchronous with the beat of the heart and the blood wave in the aorta.

The respiratory movements in the stomach are less marked than in the esophagus. Just as in the esophagus, there is, in turn, a negative and a positive pressure. This alteration causes an inflow and an outflow of air.

The Peristaltic Movements.—The peristaltic movements of the stomach which result from the action of its own fibres can be frequently seen. These, however, are not as marked as the antiperistaltic movements. The latter are of two kinds, the reversed peristaltic movement, which is seen mostly at the fundus and causes vomiting, and the antiperistaltic movement of the duodenal variety which is confined to the region of the pylorus.

The pyloric third of the stomach is the most unstable part. Jack-

son's description of the aperture seen through the tube as it approaches the pylorus states that in one instance the pylorus was surrounded by a rosette of annular folds. In another, the folds were larger. These curved in ahead of the tube and then were pushed aside by it. Finally, one large fold was encountered and when this was thrust aside a slit came into view. This changed at once into a rounded opening which was the entrance to a short tunnel in the lumen of which there were numerous small folds. From this opening and the tunnel beyond some bile-like fluid welled up.

Gastritis.—Jackson thus describes the gastroscopic findings in a case of gastritis. The walls of the stomach were covered with a thick pasty secretion and the folds were thickened. In another case the secretion was in patches. In still another case the color of the mucosa seemed darker red than the normal. In only one case did this observer find dilated capillaries such as are seen in chronic inflammation of the esophagus.

Peptic Ulcer.—Jackson has had the courage to examine the stomach in cases of ulcer. He reports his findings as follows: The first ulcer was a dirty grayish-yellow and was not punched out. The ulcer of the second case was punched out and had slightly infiltrated edges. In another case the ulcer appeared as a longitudinal slit. In still another the bed of the ulcer was dark and rough.

Malignant Disease of the Stomach.—Malignant disease of the stomach gives a varying picture in different parts of the stomach and in different parts of the same growth. There is a striking contrast between the mucosa over a cancerous infiltration and the normal mucosa. Over the growth the normal folds disappear and the surface of the lesion is irregular, granular or nodular. In most cases secretion covers the site of the growth. The growth varies in color from white through gray and yellow, to pink, red, crimson, purple or brown. Malignant disease gives the best picture for diagnostic purposes when the growth has reached the fungus stage.

When the mucosa is infiltrated but unbroken the tube can be used to palpate the growth and to determine the extent of the infiltration. In this way the growth may be pushed up to the abdominal wall and made accessible to external palpation. The sense of touch transmitted through the tube is a great help in making the diagnosis of malignancy.

Gastroptosis and Gastrectasia.—The position of the greater curvature and the vertical diameter of the stomach are easily obtained. The position of the pylorus is essential in order to distinguish between an enlarged stomach and a stomach displaced downward. If the stomach is of the infantile variety the position of the lesser curvature is easy to make out, otherwise it is not.

CHAPTER VI.

PLASTIC SURGERY OF THE NOSE AND EAR.

By Joseph C. Beck, M. D.

General Considerations.

The borderline of general surgery and otolaryngology is so indistinct by reason of the evidence furnished by the study of this subject that there is some question as to where it rightfully belongs. It is the conviction that the laryngologist and otologist have the greater claim that impels the author to treat this subject from the specialist's standpoint. The otolaryngologic surgeon is better qualified to do this work simply because he is so well informed on the requirements of these structures from their anatomic characteristics and their physiologic functions. Cosmetic considerations do not constitute the sole reason for the performance of these operations.

The deformities or malformations which call for plastic procedure may be real or imaginary. The latter comprehend slight deviations from the normal, very much exaggerated by the individual, on account of which the patient becomes the patron of the beauty doctor. The psychiatrist would be of more service. Only real deformities or malformations are considered in this chapter. Each case is a law unto itself as to the technic, yet many varieties and modifications of methods must be described. The purpose here is to illustrate rather than to give extensive descriptions of definite methods.

History.—Reconstructive surgery with special reference to rhinoplastic operation dates back to the publications of Tagliacozzi in 1597 (Figs. 208 to 222), although earlier reports of plastic surgery of the face were said to have been made by Benedictus in 1492. Tagliacozzi's work, however, was not taken up very enthusiastically until about the eighteenth century, when a large number of surgeons recognized the value of this branch of surgery. Since then important contributions have been made by Rosenstein, Dubois, Boyer, Carpeie, C. Graefe, Balfour, Zeis, Bünger, Hoffacker, Warren, Dieffenbach, Blandin, Roux, Serre, Jobert, Mutter, Post, Pancoast, Buck, Andrews, Prince, Roberts, Koenig, Israel, Joseph, Langenbeck, Ollier, Nélaton, Keegan, Roe,

Fig. 208.

Fig. 209.

Fig. 210.

Fig. 211.

Fig. 212.

Fig. 213.

Fig. 214.

Fig. 215.

Fig. 216.

Illustrations from Tagliacozzi's work.

Smith, Kolle, Reverdin, Wolfe, Krause, Thiersch, Gersuny, Lexer, Carl Beck and many others.

Indications.—In considering the indications for plastic surgery of the nose and the ear, we have in mind the correction of defects; first for the re-establishment of certain functions, such as respiration, phona-

Fig. 217.

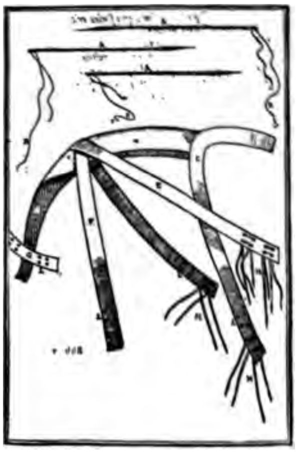


Fig. 218.

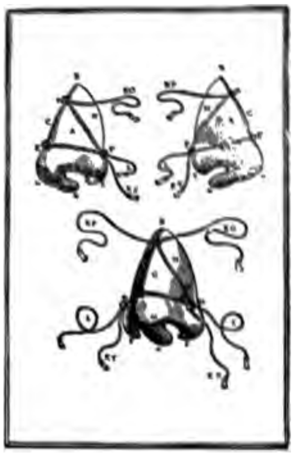


Fig. 219.

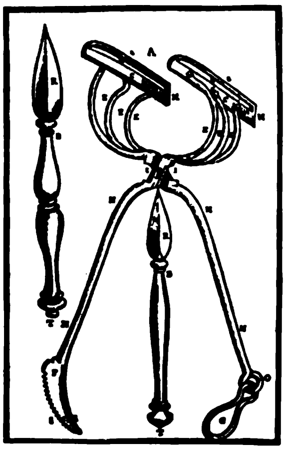


Fig. 220.

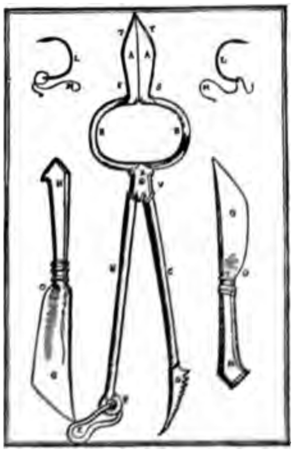


Fig. 221.

Fig. 222.

Appliances and instruments employed by Tagliacozzi.

tion, deglutition, audition; and secondly for cosmetic requirements. Of these the former purpose is by far the most important from the operator's point of view, but the latter is often of greater interest from that of the patient. At the same time the cosmetic indication must not be undervalued, as by reason of deformities and malformations many unfortunate individuals are denied equal chances and privileges in life

with their fellow-man. It can be stated unhesitatingly that even when the best results are obtained cosmetically, the patients are still much handicapped by their appearance, since such results still leave them objects of curiosity and comment. This of course is more especially true of extreme deformities of the nose and ear.

The so-called better classes are annoyed by certain minor deformities, malformations and blemishes which injure their pride, but which otherwise are of little consequence. However good a result is achieved by the operation, the patients are never entirely satisfied, and persist in their desire to have more work done. These unfortunates mostly self-centered and neurotic individuals become the prey of the so-called "beauty doctor," and many bad consequences result from the unscientific surgery of the latter.

It is best to attempt to discourage them from having plastic operations performed; furthermore, great care should be exercised when operating on them to have the patients or their immediate family assume all the responsibility as to the cosmetic results.

As a preliminary to the performance of plastic surgery it is necessary in order to obtain the best results to ascertain whether or not some general or local pathologic condition, such as lues, tuberculosis, general anemia, malnutrition is present. These are among the most frequent causes of failure. A local chronic skin infection, as eczema or granuloma, will retard or prevent healing even if the plastic has been perfect.

Important Factors.—Since there are so many varieties of deformities there are naturally a great many procedures for their correction. After all it remains for the individual operator to use his judgment as to the selection of a particular type. Again, frequently a plan must be changed during the operation and an entirely different principle applied, or perhaps a combination of different principles or operations must be adopted.

It is of great help to know the condition and position of the structures previous to the deformity. If this has existed from birth, the normal condition of the parts should be known. This is especially important in nasal and ear plastics. For instance, in constructing a nose, the surgeon is very fortunate if he can obtain a photograph taken before the deformity was acquired. Sometimes photographs of the closest relative who is known to have resembled the patient before injury, are of great service. To make a nose of the Roman style when, as a matter of fact, the patient had a short stubby, thin, straight or bulbous nose before, would be ignoring an important principle.

In ear plastic the opposite ear may be used as a model, in the majority of instances.

The selection of the method of operative procedure is naturally of great importance. A definite rule cannot always be laid down since, as has been said, each case is a law unto itself, and the operation indicated varies with the age, condition, and vocation of the patient. A rule which the writer has followed is to employ at first a method involving no loss of tissue, and consequently no additional deformity in case of failure. In other words, it is best to form the nasal structure by employing transplantation methods in preference to using flaps from the face or forehead. Similarly intranasal are to be preferred to external methods.

Flaps should be properly selected and prepared. They should be measured out previous to the operation, one-third larger than the defect, and made very plastic, that is, with not too much underlying tissue. Making them too thin or devoid of subcutaneous tissue is even a greater mistake, since their nourishment is thus likely to be affected. It is necessary to make their pedicles conform to the blood supply; that is, to construct the flaps so that the greater diameter of the vessel is in the pedicle and not in the periphery. If the pedicle is too greatly twisted strangulation of the flaps may occur.

While perfect cleanliness or asepsis is practically impossible in nasal surgery, great care should be taken not to introduce foreign microörganisms into the wound.

Thorough removal of diseased tissues as well as of cicatrices is quite as important as the free undermining of the borders of the wound. Patches of skin or mucous membrane must be dissected out, since the retention of nests and the accumulation of epithelium may prevent a good result.

Covering Defects.—It is advisable to study the principles which govern the covering of congenital or created defects. Dieffenbach, Langenbeck and others have developed this subject to such an extent that almost any form and size of defect in the skin may be covered without causing a marked deformity in the region from which the tissues are taken.

1. *Defects* may be covered by making incisions in certain directions and uniting in the opposite direction, thus loosening the tissues and uniting them in the best possible manner so that the tension is the slightest. Counter-incisions, to relax the tissues and to facilitate easy approximation of the skin, are also frequently employed. Fig. 223 demonstrates various shaped defects and the method of covering them. The arrows indicate the direction in which the flaps should be turned.

2. *Skin Grafting.*—A, Reverdin; B, Thiersch; C, Wolfe or Krause; D, Epithelial spread.

(A) The Reverdin method is to raise a small bit of epidermis

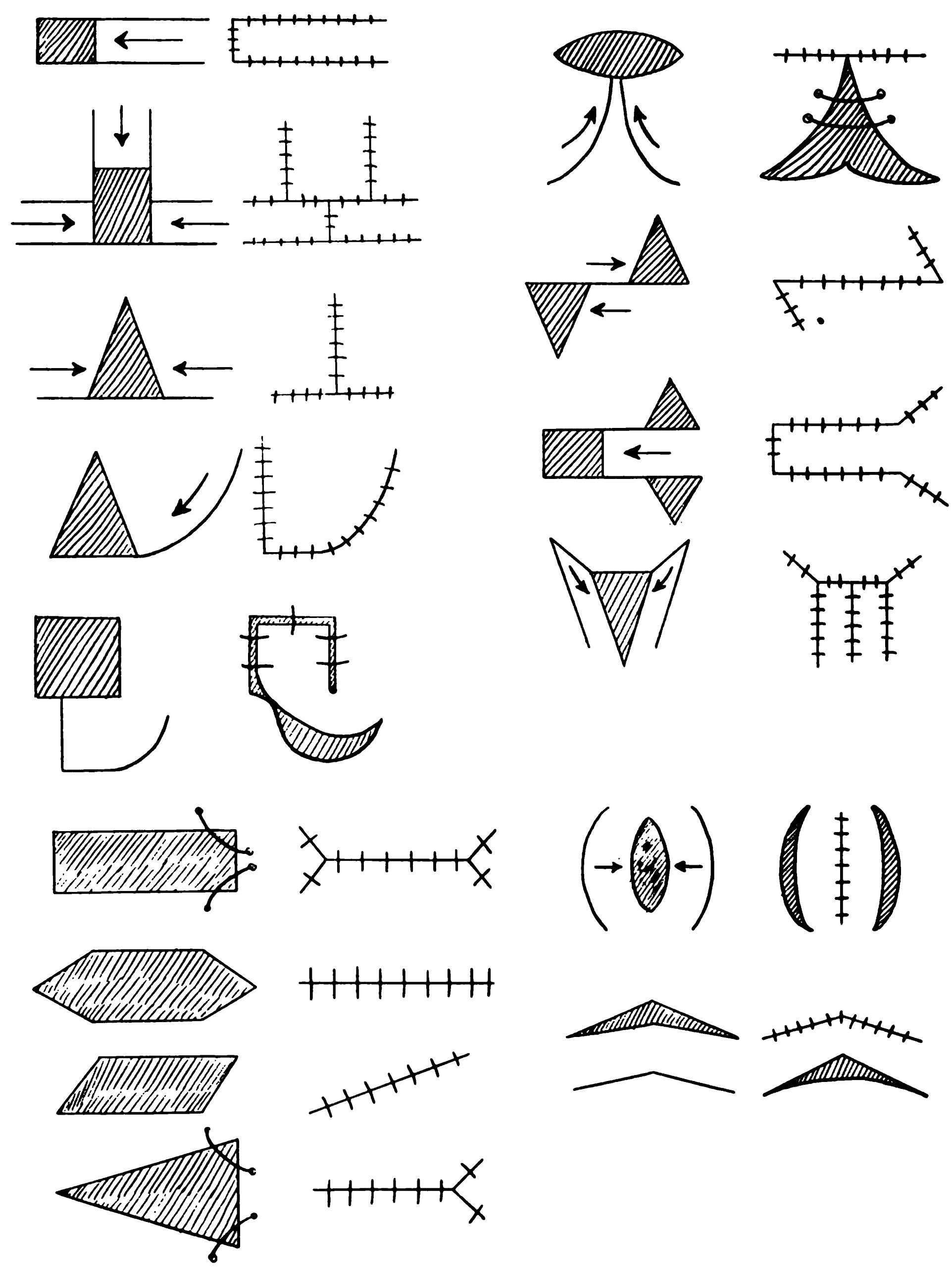


Fig. 223.

Incisions and flaps for closing defects. (Celsus.)

by means of a needle, snip it off with knife or scissors and place it over the prepared granulating surface. (Figs. 224 and 225.)

(B) Thiersch grafts are obtained either from the arm or leg (from parts containing little hair) by placing the skin on a stretch and employing a very keen razor or special knife. (Fig. 226.) With a steady side to side movement, the epidermal layer is cut off and folded on the knife. By means of this knife the graft is carried over to the granulating area to be covered, and by the aid of a needle it is laid and spread out on the defect. Particular attention is paid to the margins of the graft, so that they are thoroughly spread out, and not rolled in. This should be done as carefully as when preparing a microscopic specimen. The next graft should not be applied too close to the first,

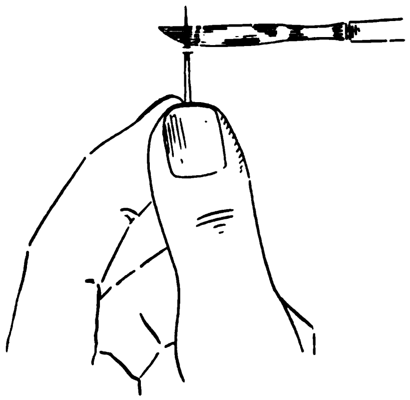


Fig. 224.
Making Reverdin graft.

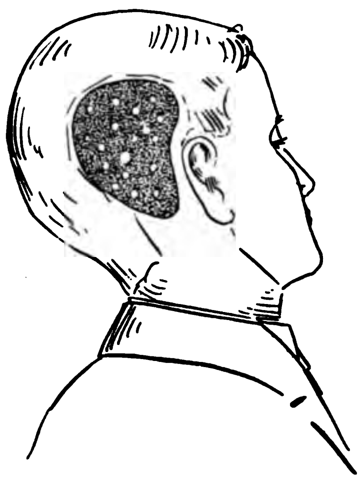


Fig. 225.
Reverdin graft applied.

and so on, since the epidermis grows quite readily from the margins and thus bridges over more easily than when the grafts are placed too close to one another. The grafts should not be too large, since these do not survive as well as small ones. After the entire defect is covered, the grafts are held to the granulating surface by means either of strips of paraffin or of rubber tissue in the form of lattice work.

(C) Wolfe or Krause grafts are transplantations of the entire skin, that is, of epithelium and corium. These should be devoid of very much subcutaneous fat and should not be too large, since their vitality is much interfered with when they are of more than one-half inch in size. These particles of skin may contain hair where such is required, as for the formation of eyebrows or on the upper lip in the male, to form a mustache.

(D) Epithelial (Aussaht) Spread. By means of a razor the surface epithelium is scraped until a slight oozing of serum (but not blood) occurs, and then this scraped off epithelium is smeared on the granulating surfaces in a very thin layer. It is best covered with a thin layer of paraffin before covering with gauze and bandage.

Recording Cases Before, During and After Correction.—As has been stated it is best in all cases to obtain a photograph of a patient before the occurrence of the deformity. This will give the operator

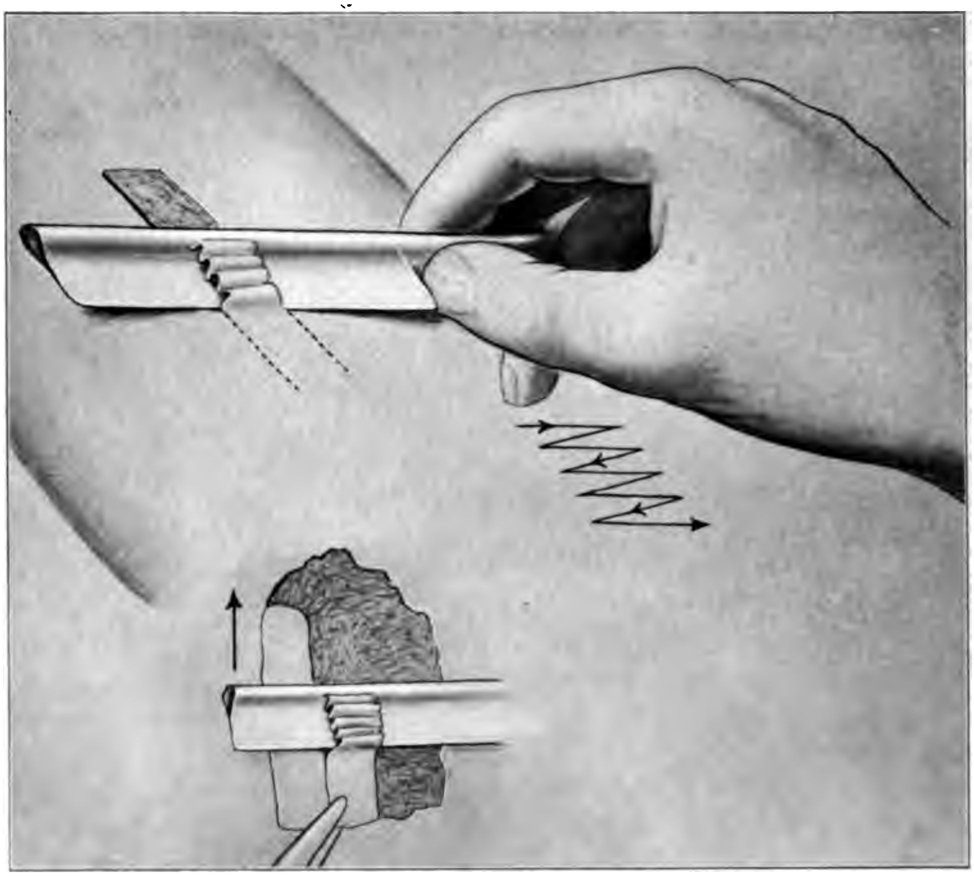


Fig. 226.

Making and applying Thiersch graft.

the advantage of reproducing as nearly as possible the original condition of the parts. If no photograph is obtainable or if there be a congenital defect, the operator will be called upon to use his judgment in the reconstruction. This should be in conformity with the rest of the features and facial expression. It is necessary to know that a broad face, which is known as the eurygnathous variety, will require

a formation or reconstruction of a broader nose than if the face is protruding, or of the prognathous type. Again, if the face be of the non-protruding variety, orthognathous, a short nose is best suited to it. (Roe.)

The next step is to obtain a very detailed history and to make a thorough local and general examination. Intranasal and pharyngeal inflammatory and obstructing conditions must be noted as well as the local pathologic changes that may be present on the external nose or ear. As to the general conditions existing, syphilis, tuberculosis, severe anemia, and malnutrition must receive the strictest recognition.

Fig. 227.
Stereoscopic photograph of plaster cast.

A number of photographs from every angle should be taken. The author is now accustomed to take stereoscopic photographs, which are a vast improvement over the single exposure, since they bring out much more clearly the various defects, however small they may be.

Plaster casts (Fig. 227) are excellent positive records of the condition present. The following method is used for making casts: Fill a one-half pint bowl half full with tepid water and plaster of Paris (dental) until the latter is submerged. Pour off excess water and stir to proper consistency. When one desires quick setting of the plaster, a pinch of table salt is introduced into the warm water before the plaster is added. Before applying it to the face a fine layer of vaselin is spread upon the skin and the anterior nares or the nasal apertures are plugged loosely with cotton. A small rubber tube is kept ready to

place into the patient's mouth at the last moment, just before the plaster is put over the mouth, in order that the patient may breathe while the plaster hardens. The mask is begun by placing the plaster in thin layers about the forehead over the closed eyelids, cheeks, lower jaw, nose, upper lip, lower lip, and closely about the tube. This first layer is reënforced with a goodly quantity of plaster and the mask is allowed to harden. The subject should avoid any facial movements, in fact he should lie perfectly still until the plaster is set, which takes usually from three to five minutes after the mask is finished.

The removal of the formed mask is now very carefully manipulated so that it may come off in toto. If it should unfortunately break into two or more parts, it is carefully placed together and cemented, as is done by the dentist in making plaster casts. In fact this whole procedure is so much like the making of dental impressions that the author would recommend that a dentist be employed for the purpose. To make the positive from this mask is the next procedure, and this is accomplished by painting the inner surface of the thoroughly dried cast (mask) with separating fluid and pouring into it plaster of Paris until it is thoroughly filled. This is now allowed to harden and dry, when the mask is carefully picked off from the positive at the pink line of demarcation of the fluid. The chips and defects on the positive cast, caused by this tedious process of picking off the mask, must be repaired with plaster.

Secondary casts and photographs, showing the effect of treatment, are of service as additional records, while stereoscopic photographs are even better than plaster casts.

Rhinoplasty.

Classification of Nasal Deformities.

I. According to Roe:

- Deformities
  - Bony portion
    - Vertical
      - Convex
      - Concave
    - Lateral
      - Spatulated
      - Deflected
  - Cartilaginous portion
    - Tip
      - Excessive deficient tissue
      - Deflection from median line
    - Wings
      - Collapsed
      - Expanded

II. ACCORDING TO KOLLE. (In deficiencies particularly referable to paraffin injections.)

1. Anterior Nasal Deficiency.. { Superior one-third. / Middle one-third. / Inferior one-third. / Superior one-half. / Inferior one-half. / Total. }

TOTAL.

2. Lateral Insufficiency....... { Unilateral. / Bilateral. }

3. Lobular Insufficiency.

4. Interlobular Insufficiency.

5. Alar Deficiency............ { Unilateral. / Bilateral. }

6. Subseptal Deficiency....... { Partial. / Complete. }

III. Author's Classification.

A. Etiology.—Traumatic, Luetic; Congenital; Tubercular and Lupus; Simple infections, as abscess; Perichondritic; Atheromatous, or Acne Rosacea; Neoplasms, malignant and benign; Gross Imagination, or Vanity.

B. Form.

1. Large hump nose.
2. Twisted nose.
3. Kinked and double kinked.
4. Saddleback, kinked and with wide alæ.
5. Pinched pointed, with collapsed alæ.
6. Flat or squashed, with large alæ and large vestibules.
7. Notched.
8. Congenital absence of premaxilla and columellar cartilage.
9. Pushed-in nose.
10. Absence of external nose and septum.
11. Unilateral deformities.
12. Hare-lip nose.
13. Combination of nasal and face deformities.
14. Pound or hypertrophic nose.

Methods of Procedures in Nasal Deformities and Malformations.—

I. German or French method, including skin grafting.
II. Italian or Tagliacozzi's method, with modifications.
III. Hindoo or Indian method.
IV. Double transplantation method (toe to hand, to nose).
V. Finger method.
VI. Clavicle method.
VII. Implantation method (paraffin, etc.).
VIII. Reduction method.
IX. Artificial method.
X. Orthopedic method (Carter's clamp, pins, etc.).
XI. Intranasal method.
XII. Miscellaneous and combination methods.

I. German or French Method. (Facial.)

When a subtotal destruction or an unilateral defect is to be corrected this method gives excellent results. The transposition of the newly-formed parts may be accomplished by sliding or pedicle formation. Small defects may be covered by rearranging flaps from the nose itself as shown in Figs. 234 and 235.

The nasolabial fold offers the best place for pedicle flaps. Flaps for building up the prominence of a nose as well as for forming an epidermal lining of the nose are frequently formed from the cheeks and turned outside in, as shown in Figs. 228 and 229. Columellæ may be made from the point of the nose, from the outer part of the middle of the lip, or from the mucous membrane of the lips, and passed through in buttonhole fashion, as shown in Figs. 252-260. It is most important to loosen the parts thoroughly and to effect perfect adaptation of the margins. Portions of the nasal bones, nasal processes of the superior maxilla or of the premaxilla and the floor of the nose, are utilized for support of the nose formed after this method. (Figs. 286 and 287.) Other materials for support are cartilage from the septum resected from other patients, or, clavicle, and bones from the toes, fingers, and the anterior surface of the tibia. (Figs. 307-314.)

Correction of Unilateral and Partial Deficiencies of the Nose.

Legg's Operation.

1. Make a small tongue-shaped flap, with its hinge pedicle at the nasolabial crease. (Fig. 228.)

2. Turn over with skin surface into the vestibule, and suture all about the margins of the ala, which have been freshened up, and close created defect on the cheek. (Fig. 229.)

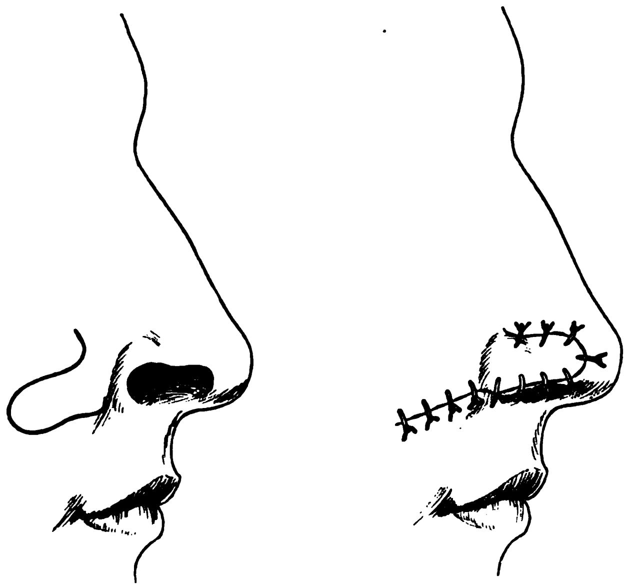


Fig. 228. Fig. 229.

Legg's operation for correction of unilateral and partial deficiencies of the nose.

One Week Later.

3. Sever the pedicle and readjust, then suture to the remaining alar margins.

4. Cover the flap with a thin Thiersch graft.

Koenig's Operation.

1. Make a semilunar incision through the ala remaining and dissect the margin away. (Fig. 230.)

2. Take a Wolfe graft from the thick skin of the back of the neck and implant into the alar defect. (Fig. 231.)

Von Esmarch's Operation.

1. Make a flap in the nasolabial fold. (Fig. 232.)

2. Turn on its pedicle with the skin outwards and suture. (Fig. 233.)

3. Eventually sever the pedicle one week later and readjust parts.


Fig. 230.

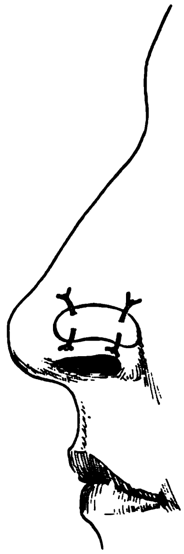


Fig. 231.

Koenig's operation.

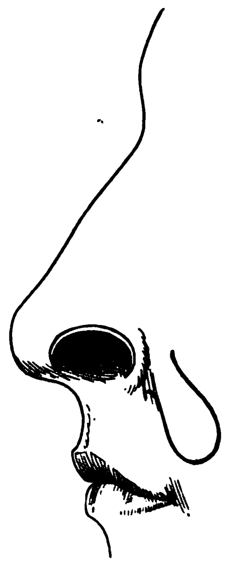


Fig. 232


Fig. 233.

Von Esmarch's operation.


Fig. 234.

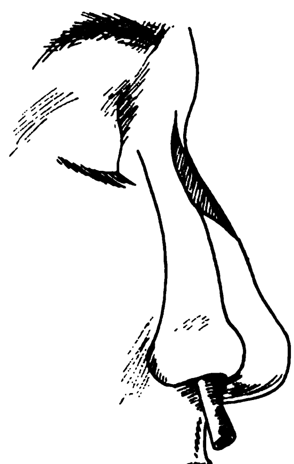


Fig. 235.

Von Langenbeck's operation.

Von Langenbeck's Operation.

1. Freshen up the surfaces on the defect.
2. Make a flap on the healthy side of the nose with the pedicle over the side of the defect. (Fig. 234.)
3. Dissect this flap loose and stitch into the prepared defect, turning in the lower margin of the flap so as to make the nostril have a dermal surface. (Fig. 235.)
4. Cover the newly-formed defect either with skin graft or dissect loose the tissue of the cheeks and cover the defect by sliding the skin over it.

Fig. 236. Fig. 237.
Dieffenbach's operation.

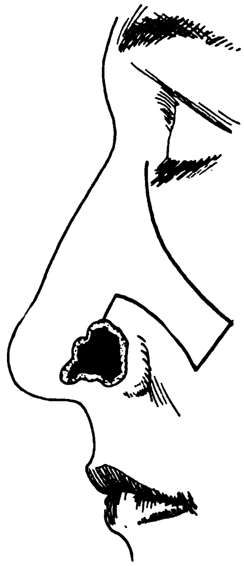


Fig. 238.
Von Esmarch's operation.

Dieffenbach's Operation.

1. Make a reversed V-shaped incision through the ala above the defect and dissect freely. (Fig. 236.)
2. Reunite in the form of three three-cornered flaps. (Fig. 237.)

Von Esmarch's Operation.

1. Freshen up the margins of the defect.
2. Make a flap of the side of the cheek with a pedicle on the side of the nose. (Fig. 238.)
3. Implant flap and suture on three sides.

One Week Later.

4. Sever the pedicle and complete the closure of the defect on the ala as well as of the newly-formed defect on the side of the nose and cheek. (Fig. 238.)

Busch's Operation for Partial Loss of Tip and One Side of the Nose.

1. Form a lateral flap. The pedicle is formed on the side of the cheek opposite to the defect of the ala, and the main body of the flap is made from the bridge of the nose. (Fig. 239.)

2. Remove the undesirable skin margin of defect.

3. Dissect the flap and suture in position, the prominent convex border of the flap being fitted well into outer margin of the defect. The tongue-shaped portion makes a well-adjusted tip and columellæ covering.

4. The newly-formed defect is covered and corrected one or two weeks later, when the pedicle is severed.

Fig. 239.

Busch's operation for partial loss of tip and one side of nose.

Nélaton's Operation.

1. Form two quadrangular flaps from the cheeks, the bases of which are situated over the bridge of the nose and angle of the eye. One of the flaps should have an additional central flap to form the columella. (Fig. 240.)

2. Freshen the margins of the defect.

3. Bring flaps together and suture in place over the filtrum of the columella.

4. Cover created defect either by Wolfe or Thiersch grafts, or slide over the skin from the cheeks.

Syme's Operation.

1. Two lateral flaps are made, one to each side of the defect, extending to the lateral portion of the nose and to the cheeks, both these flaps having a common central pedicle over the root of the nose. (Fig. 241.)
2. Freshen up the margins of the nasal defect.
3. Suture the two flaps together in the median line.
4. Turn the skin in at the lower margins of the flap, and suture so as to make a cutaneous surface where the nostrils will subsequently be formed. (Fig. 242.)

Fig. 240.
Nélaton's operation.

5. Suture the two lateral flaps into the raw surface on the side of the nose.
6. Dissect the skin of the cheek and bring it close to the lateral flaps and suture. Any defect remaining may be covered by skin grafts or be allowed to granulate.
7. Tubes of stiff rubber are placed in each primitive nostril.
8. Subsequent formation of the columella from the upper lip.

CORRECTION OF TOTAL LOSS.

Helferich's Operation (French Method).

1. Make a quadrangular flap from one side of the cheek with its pedicle on the side of the nose, for the purpose of support and to line the nose with skin. (Fig. 243.)

Fig. 241.

Fig. 242.
Syme's operation.

Fig. 243.

Fig. 244.
Helferich's operation for total loss of nose.

2. Make a somewhat oblong flap from the other cheek with its pedicle placed towards the inner corner of the eye, for the purpose of covering the first flap, and reconstruct the nose. (Fig. 243.)

3. Dissect and turn the quadrangular flap across the naval defect, and suture the previously freshened margins of the nasal defect, facing its skin surface into nasal cavity. (Fig. 244.)

4. Dissect oblong flap and bring it in contact with the denuded surface of the first flap, and suture in place.

5. Close, by sliding and readapting the skin about the cheeks over the newly-formed defects.

One Week Later.

6. Sever pedicles and readapt the parts to a smoother healing surface; secondary operation upon the alæ and columella.

Roberts' Operation for Sunken Bridge With Upturned Lobule or Tip of Nose. Fig. 245.

1. A transverse incision is made into the nasal cavity, the tip of the nose being pulled down so that the nostrils appear horizontal. (Fig. 246.)

2. An inverted V-shaped incision is made between the eyes up to the forehead. (Fig. 246.)

3. The skin and subcutaneous tissue between the first transverse and the second V incision are dissected thoroughly.

4. This dissected skin is brought down, the point of the flap displaced as low as possible, and the lower defect broadly sutured. (Fig. 247.) This forms a good prominence over the former depression. Dressing should be retentive so far as to hold the tip of the nose down.

Roberts' Operation for Sunken Saddle-back Nose.

1. Sever the lobule and alæ from their bony and cartilaginous attachments at the deepest part of the saddle.

2. Draw the lobule and alæ down so as to bring the nostrils into an almost horizontal plane; this leaves a conical defect into the nasal cavity. (Fig. 248.)

3. Make two small skin flaps from the cheeks with their pedicle towards the root of the nose. (Fig. 248.)

4. When these flaps are dissected, they are turned with their epidermal surfaces towards the nasal cavity and are united one to the other as well as to the upper portion of the newly-formed defect in the nose. This brings their raw surfaces externally for granulation formation and subsequent support for the newly-formed skin flaps.

Fig. 245.

Fig. 246. Fig. 247.

Robert's operation for sunken bridge with upturned lobule or tip of nose.

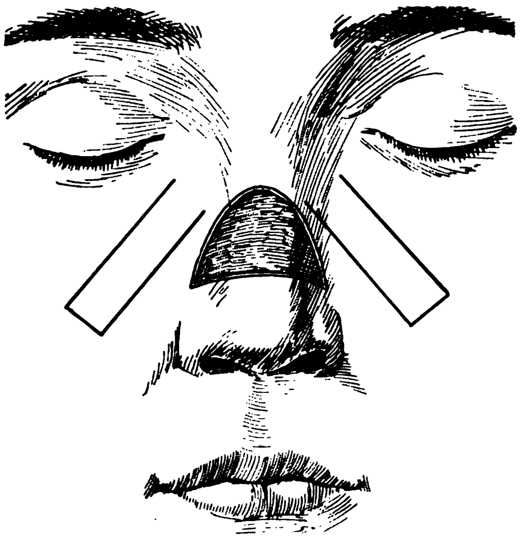


Fig. 248.

Fig. 249.

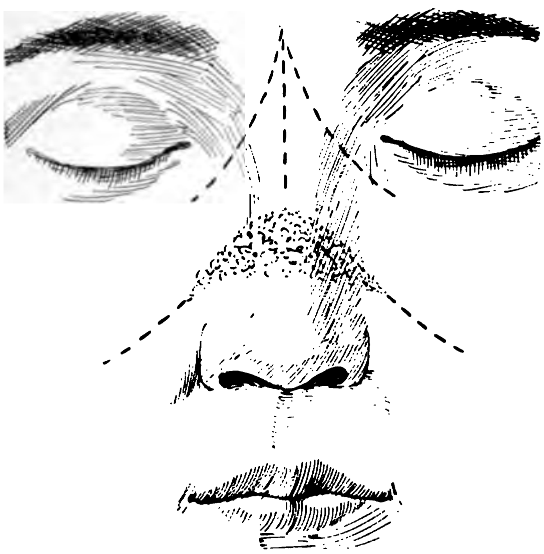


Fig. 250.

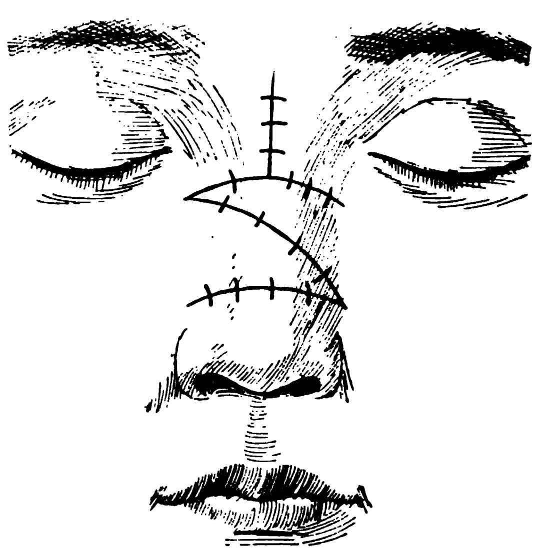


Fig. 251.

Robert's operation for sunken saddle-back nose.

The defects in the cheeks created by these flaps are at once united. (Fig. 249.)

5. About one week to ten days later, the irregularities about the base of these cheek flaps are corrected by incisions and proper sutures so as to obtain a smooth surface.

6. When all the inflammatory reaction has disappeared, usually in about three to four weeks, an inverted V-shaped incision is made down to the bone. Corresponding to this incision just above the margin of the nasal defect, which is now covered by the inverted skin flaps, a similar incision is made except that the legs of the V run more horizontally. While the legs of the upper incision terminate below the eyes, close to the inner corner, the lower come out further on the cheeks, giving greater plasticity to the flaps. The apices of the two inverted V-shaped incisions are now joined by a vertical one immediately over the crest of the nose. (Fig. 250.)

7. These two flaps, rhomboid in form, are dissected very freely from the underlying tissues and the cicatrized surface of the skin flaps covering the defect freshened by gently scraping with the knife blade. One flap is turned so as to fit its extreme point or tip into the opposite extreme point of the defect and is anchored by a suture; then the second flap is brought above the first so as to fill in the defect to the greatest extent, and is anchored. This will leave a somewhat triangular defect at the root of the nose and lower portion of the forehead which is closed by three or more sutures in a vertical line. The two flaps are now sutured to the various margins and to themselves as shown in Fig. 251.

FORMATION OF A NEW COLUMELLA (FROM THE UPPER LIP).

Dieffenbach's Operation.

1. Two parallel incisions, separated about one-fourth inch, are made through the entire thickness of the upper lip up to the margin of the nasal floor. (Fig. 252.)

2. Turn this tongue-shaped flap so that the skin surface looks into the nasal cavity and mucous membrane externally, and locate a point where the free end of this flap will touch the nasal tip without undue tension or twist of the base of the flap.

3. Denude this located area of skin. (Fig. 252.)

4. Remove the mucous membrane from the tip of the tongue-shaped flap.

5. Suture this tip into denuded surface of nasal tip. (Fig. 253.)

6. Liberate the margins of the newly-formed defect in the middle of the lip.

7. Suture skin and mucous membrane separately. (Fig. 253.)

8. If the operation is on a man, it may be necessary to denude the tongue-shaped flap of its dermal covering as the hair would subsequently irritate the interior of the nose.

Fig. 252.

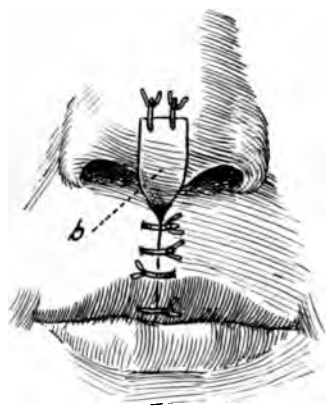


Fig. 253.

Dieffenbach's operation for formation of new columella from the upper lip.

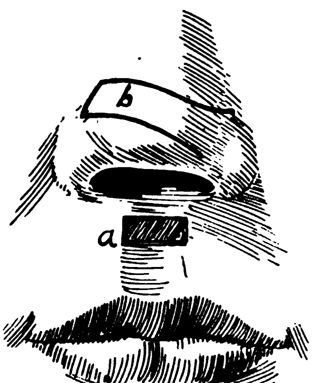


Fig. 254.

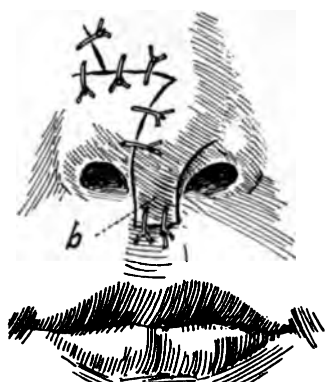


Fig. 255.

Operation for formation of new columella from the dorsum of the nose. (Hindoo method.)

From the Dorsum of the Nose (Hindoo Method).

1. An oblong flap is made, the pedicle being at the side of the ala running to the tip of the nose.

2. A defect is made at the junction of the upper lip with floor of the nose. (Fig. 254.)

3. The flap is turned downward and sutured into this defect. (Fig. 255.)

4. The defect on dorsum of nose is sutured or a skin graft is used.

5. Any slight irregularities are to be corrected at a subsequent time when the pedicle is severed.

Fig. 256.

Fig. 257.

Fig. 258.

Fig. 259.

Fig. 260.

Lexer's operation for the formation of columella from the mucous membrane of the upper lip.

Lexer's Operation for the Formation of Columella (from the Mucous Membrane of the Upper Lip).

1. Construct a tongue-shaped flap with its base towards the gingival margin on the under surface of the upper lip, made up of mucous membrane and some underlying submucous tissue. (Fig. 256.)

2. Dissect it loose, and close to its base remove the epithelial surface of a small transverse strip which will subsequently be within a buttonhole of the upper lip. (Fig. 257.)

3. Form the flap in a sort of a roll, suturing the margins. (Fig. 258.)

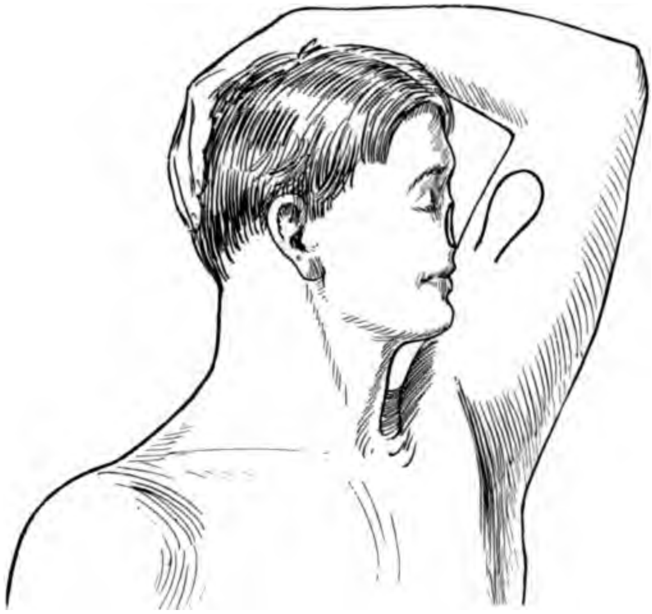


Fig. 261.

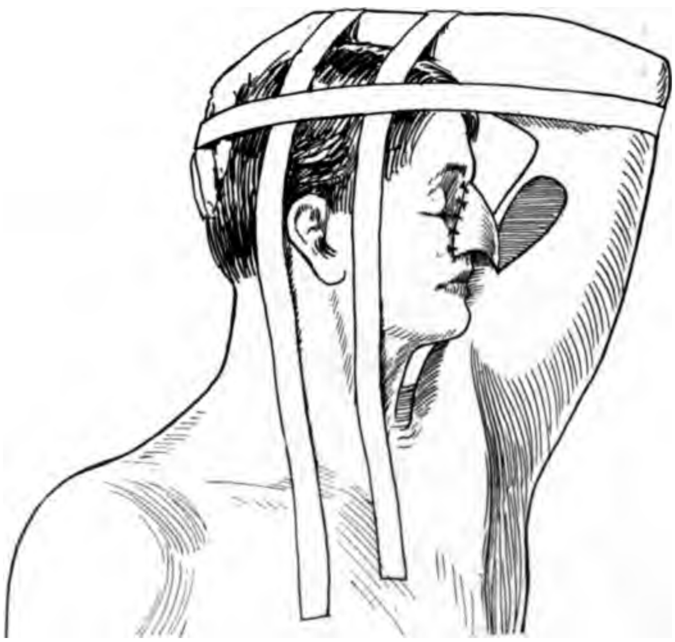


Fig. 262.

Italian or Tagliacozzi's method.

4. Make a buttonhole in the center at the junction of the upper lip and floor of the nose, through the thickness of the lip, in front of the pedicle of the flap. (Fig. 259.) Also make a notch at the tip of the nose.

5. Bring the flap through and suture into the notch at the tip of the nose and also at the buttonhole. (Fig. 260.)

Fig. 263.
Italian or Tagliacozzi's method.

II. Italian or Tagliacozzi's Method.

This method, which is the oldest, is not employed to any great extent at the present time, as the patient is very much inconvenienced by having his arm held in a very constrained position for such a long

period. Its purpose is to obtain a flap from the arm as shown in Fig. 261.

1. The flap may be allowed to become firm and of proper size by placing rubber tissue, Cargile membrane or anointed gauze between the denuded surface so as to prevent it from reuniting. The flap should always be made one-third larger than the surface to be covered on account of the subsequent shrinking.

2. After the parts about the nose are freshened and loosened up the flap is sutured for about two-thirds of the distance, holding the hand over the top of the head and fixing it by means of adhesive plaster as in Fig. 262. The pedicle should not be twisted too acutely.

3. A complete immobilization plaster cast is put over this primary adhesive fixation, care being taken to protect the eyes while it is being applied. After it has thoroughly hardened, spaces or windows are cut out so as to expose the wound, the eyes, ears and mouth, as in Fig. 263. The wound is covered by a separate dressing. This cast is allowed to remain until the parts have healed, the stitches being removed usually in one week to ten days. It is then time to sever the attachment of pedicle to the arm. The remaining portion of the defect about the nose is freshened and loosened up, the pedicle trimmed to fit the parts, making allowance for a columella, and the external parts of the nose finished. The skin defect on the arm is cleansed, the margins are freshened and loosened up and sutured. Grafts may be used, or the defect may be allowed to heal by granulation.

Israel's Operation.

Instead of obtaining the flap from the arm, one is made from the forearm, and the arm and forearm are so placed as to make the patient most comfortable, as shown in Fig. 264. The retention of the arm is the same as in the Tagliacozzi method.

1. Make incision in left forearm symmetrically on both sides of the ulnar edge, and form a trapezoidal skin flap. The small part of the trapezoid which points towards the wrist should be 4.5 cm. from the styloid process. (Fig. 265.)

2. With a chisel, outline a bone flap from the ulna in connection with the partially dissected skin flap 0.75 cm. wide and 6 cm. long. (Fig. 265.)

3. With a fine saw this bone sliver is severed from the ulna, care being taken that it remains attached to the skin flap and to the ulna at the upper end. Iodoform gauze is interposed to prevent reunion.

A Few Days Later.

4. Break the bone bridge at the point where the tip of the nose is

to be formed and dress in this form. Allow for greater thickening of parts for another three to four days.

5. Transplant flap to nasal defect and fix at the side as shown in Fig. 264. Immobilize by the usual method of plaster of Paris jacket.

Fig. 264.

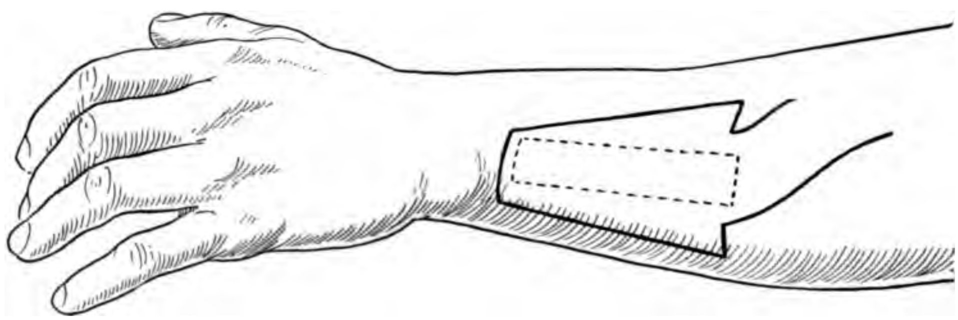


Fig. 265.

Israel's operation.

Two Weeks Later.

6. Sever the bony and skin pedicle and readjust parts to form a nose. The bone should be united with the nasal spine at the floor of the nose and the skin sutured about the side of the nose.

7. Form the columella and nostril from the remaining skin flap that was purposely taken for their formation.

Dieffenbach's Operation.

1. Outline a trapezoidal flap above the elbow on the inner surface, one-third larger than the newly-formed nose is to be.

2. The heavy lines in Fig. 266 show the formation of incisions and this skin flap is dissected freely.

3. Turn in one-half of this flap so as to bring the skin next to the

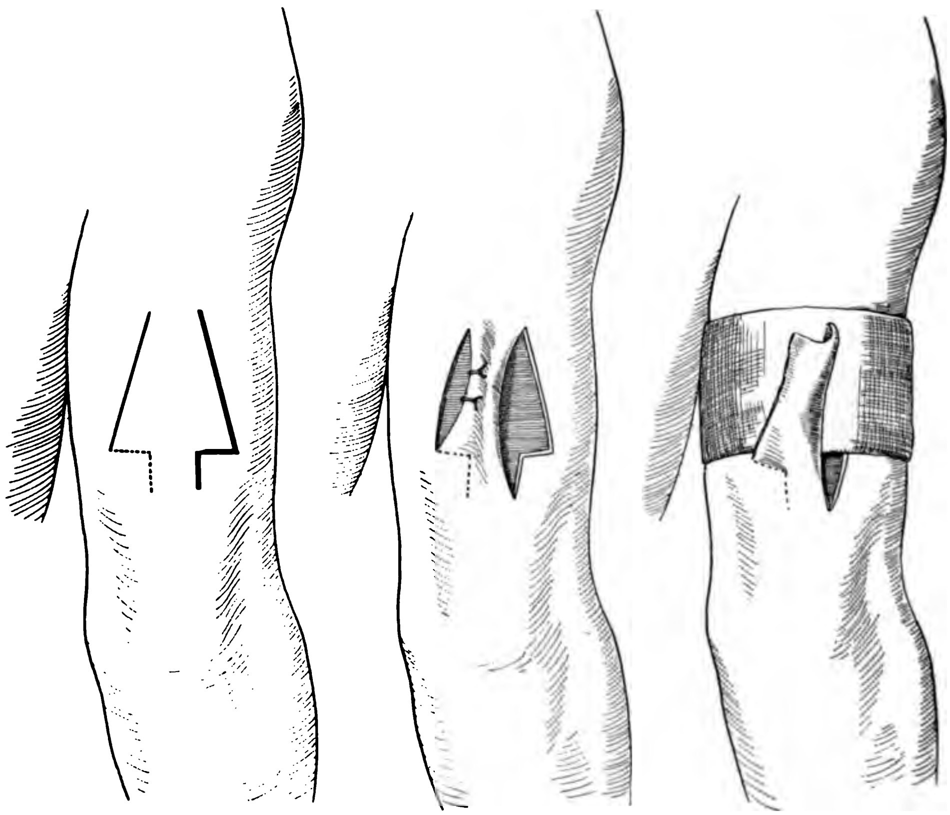


Fig. 266. Fig. 267. Fig. 268.

Dieffenbach's operation.

raw surface of the arm in order to prevent adhesion and also to form the so-called roll of the dorsum of the future nose; fasten by two sutures. (Fig. 267.)

Six Weeks Later.

4. Sever the upper part of the flap and turn downward. Remove the two stitches and lay the flap open partially. (Fig. 268.)

5. Freshen up margins of the nasal defect and suture in this new flap as in the usual Italian method.

Two Weeks Later.

6. Sever the pedicle and readjust the parts to form the alæ and columella.

Nélaton's Operation.

1. Form a pedicle flap from the forearm and attach to the margins of the defect. (Fig. 269.)

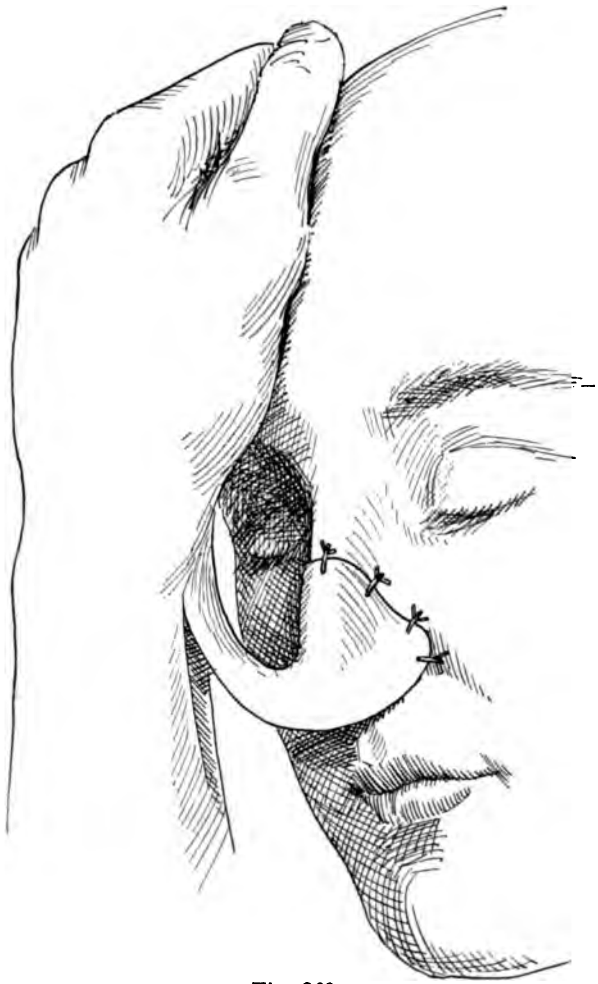


Fig. 269.

Nélaton's operation.

Two Weeks Later.

2. Sever the pedicle.

3. Form two flaps from the outer margin of the alar openings outward and downward as low as the inferior maxilla in the naso-labial fold. (Fig. 270.)

4. Turn these so as to make skin-lined nostrils and also a columella or septum support for the new formed flap, which should also include a small flap for the formation of a double columella. (Fig. 271.)

5. Suture these flaps to one another and close the defect in the nasolabial fold. (Fig. 271.)

Two Weeks Later.

6. Sever the pedicles of the two flaps and adjust them to the alæ of the nose. Also reconstruct the columella.

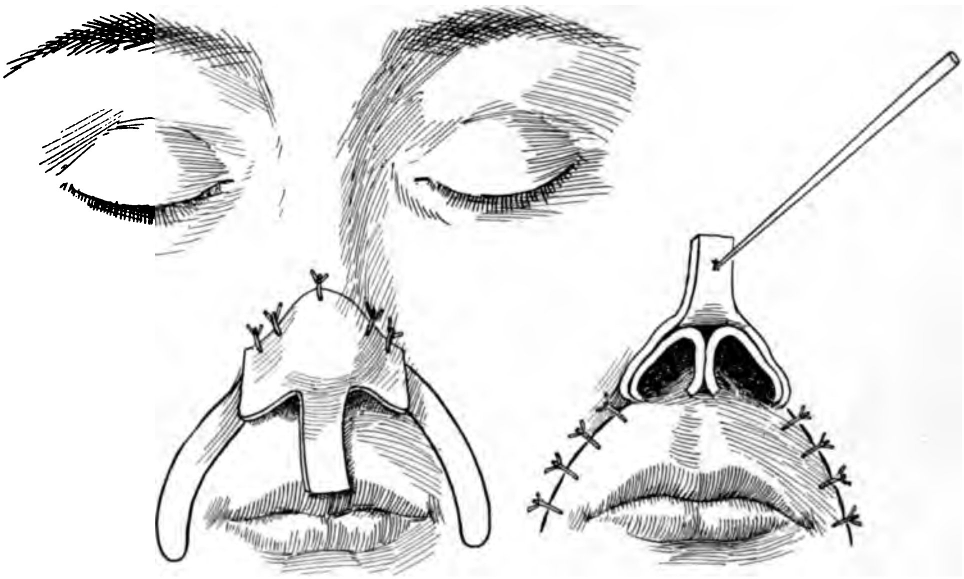


Fig. 270. Fig. 271.
Nélaton's operation.

III. HINDOO OR INDIAN METHOD.

This is by far the preferable method when there is so much destruction of the nose that insufficient tissue is obtainable in the immediate neighborhood, as the cheeks or the nose itself. The flaps may vary as to their shape and outline, according to the area to be covered and according to the area of the alæ or upper portion of the nose that is present or can be utilized. (Fig. 272.)

The character and extent of the defect determine the side of the forehead from which the flaps are to be made. In this particular, the flaps should be so constructed that the pedicle should contain the angular artery, which should be subjected to very little twisting. In fact no tension must be exerted anywhere on these flaps. The flaps may

be formed of the skin and part of its underlying connective tissue only, or they may contain the periosteum and even a portion of the external table of the frontal bone. The frontal defects thus created by the turning of the flap may be covered in several ways. By loosening up the

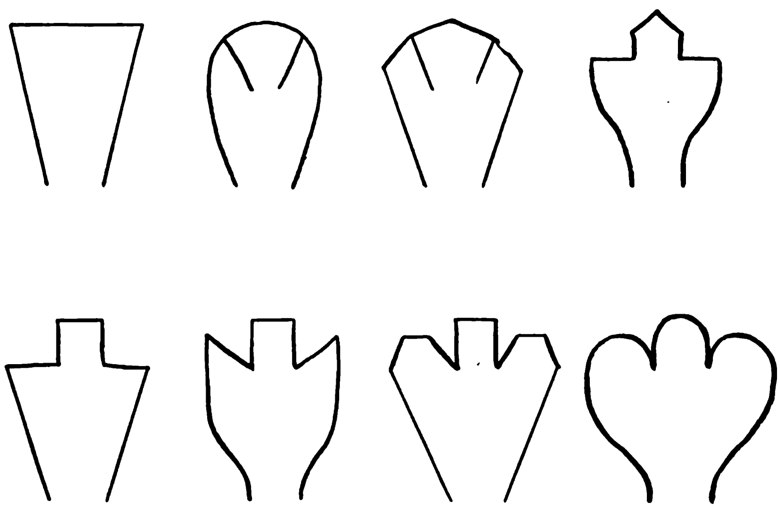


Fig. 272.
Hindoo or Indian method of flap formation.

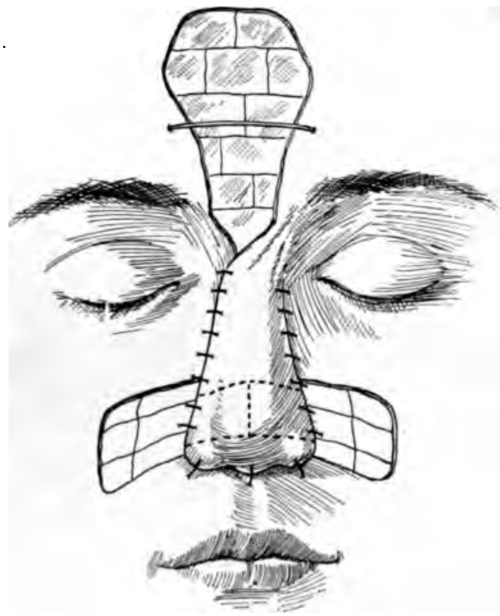


Fig. 273.
Thiersch's operation for total loss of nose.

margins and drawing the parts together as far as possible, the granulation may be encouraged; a Thiersch skin graft may be used, or the entire area may be covered by skin graft (Thiersch, Wolfe or Krause). After union takes place the pedicle is severed and the stitches are removed. It requires usually about eight to ten days before the pedicle is cut off, and it is frequently very thick and large, so that it must be trimmed off and adjusted to the still existing defect between the eyebrows and root of the nose.

Thiersch's Operation for Total Loss of Nose.

1. Make two small quadrangular flaps from the cheeks at the lower portion, forming their hinge at the side of the nose where they will constitute the inner surface of the nostrils and ala of the nose. (Fig. 273.)
2. Dissect them loose and turn them with their dermal layer towards the nasal cavity.
3. Suture one to the other in the median line.
4. Make a frontal pedicle flap and suture into the freshly denuded margins on the side and lower part of the nose (Fig. 273.)
5. Cover newly-formed defects by Thiersch grafts.

Nélaton's Operation for Total Loss of Nose (Indian Method).

1. Expose entire length of costal cartilage of the eighth rib.
2. Excise.
3. Trim down to a size 2.5 cm. long by 3 mm. wide.
4. Cut a notch where the point of the nose is to be formed by this cartilage, that is, about 0.75 cm. from the end nearest to the base of the forehead pedicle.
5. Outline the forehead flap.
6. Incise the base of this flap down the bone for about 0.5 cm. and make a tunnel to fit the cartilage strip.
7. Introduce cartilage strip with its notch towards the skin incision so that it is between the frontal bone and its periosteum. (Fig. 274.)
8. Close skin-periosteal incision.

Two Months Later.

9. Make an incision about the nasal defects in such a manner that two lateral and one upper central flap will result. (Fig. 274.)
10. Turn these over so that the skin surfaces will look into cavity of nose.
11. Stitch with catgut so as to retain them in position.

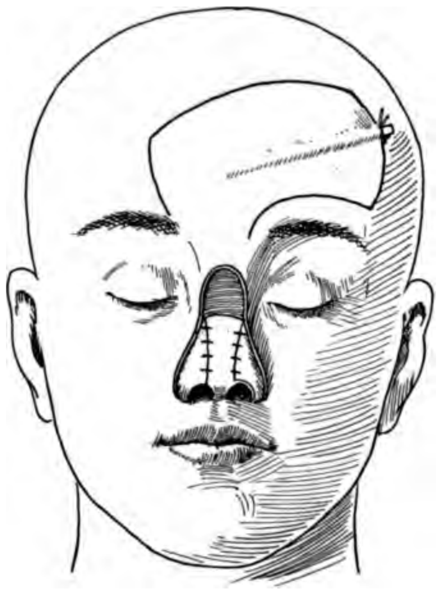


Fig. 274.

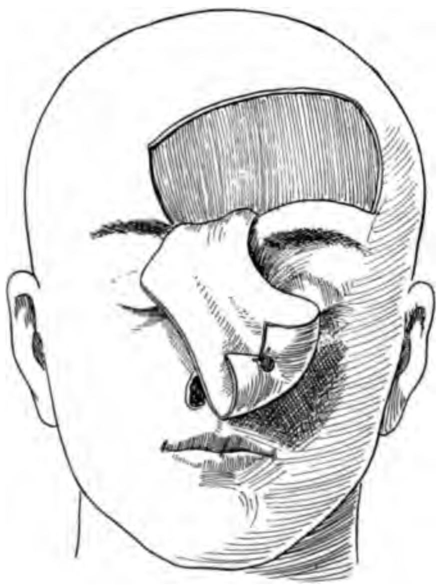


Fig. 275.

Fig. 276.

Nélaton's operation for total loss of nose.

12. Cut forehead flap with its pedicle towards the opposite inner corner of the eye, over which the flap is situated as shown in Fig. 275. This flap contains the previously introduced cartilage with its underlying periosteum.

13. Turn the flap downward, over the previously turned flaps made from the margin of the defects. The flap should be fashioned into a sort of a tip of the nose by bending the cartilage where the notch had been cut in it, so as to make a proper columella.

14. Stitch in place. (Fig. 276.)

15. The defect in the forehead is closed by skin graft or sliding flaps. [Author's comment.—This forehead defect can be covered much better by sliding the skin and making counter release incisions in the hairy portion of the scalp.]

One Week Later.

16. Cut pedicle, trim it and implant in existing defect at the root of the nose.

Koenig's Operation (Indian Method).

1. Make a transverse incision across the depressed portion of nose into the nasal cavity and dissect loose the tip of the nose, so as to bring it into a more horizontal position. (Fig. 277.)

2. Make a strip-shaped flap from the root of the nose straight towards the hair line, all tissues being severed to the bone. (Fig. 277.)

3. With a small chisel cut through the external table along the course of the incision made in this strip-shaped flap.

4. Take off this layer of external table, periosteum and skin and turn it downward into the newly-formed defect, bringing the uppermost margin of the strip-shaped flap below the lower margin of the defect and stitch it. This causes the skin surface to look into the nasal cavity while the raw bony surface is external. (Fig. 278.)

5. Break the curved bony bridge of this turned down flap so as to give a curve to the nose.

6. Make a lateral frontal flap and turn it down in the usual manner by twisting a pedicle covering the denuded bony surface. (Fig. 277.)

7. Subsequent trimming of the pedicle at the root of the nose, with readjustment of the newly-formed irregularities at this point must follow, that is, excision of the skin between the root of the nose and the narrow flap. (Fig. 279.)

Fig. 277.

Fig. 278.

Fig. 279.

Koenig's operation.

Keegan's Operation for Subtotal Loss of Nose, in Cases of Hacked Noses (Indian Method).

1. Two flaps are formed from the remaining skin over the nasal bones, leaving their broad pedicles attached at the bony margins of the deformed nose. (Fig. 280.)

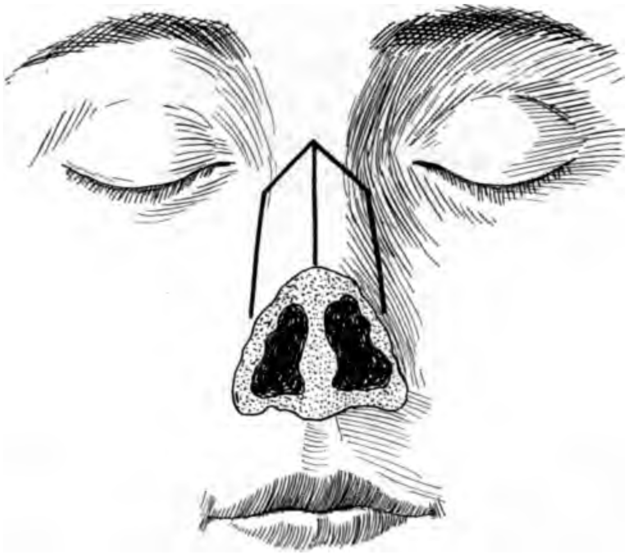


Fig. 280.

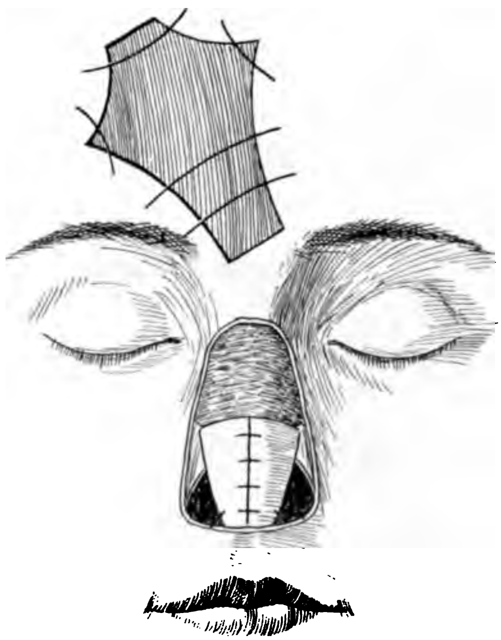


Fig. 281.

Keegan's operation for subtotal loss of nose, in cases of hacked noses.

2. These two flaps are dissected off and turned at the hinged pedicles with their dermal surfaces towards the nasal cavity. They are sutured together and into the floor of the nose. (Fig. 281.)

3. The denuded surface from the root of the nose to where the tip is to be formed is now covered with a frontal flap which is so constructed as to bring the pedicle at one or the other inner angle of the eye, that is, an oblique flap. (Fig. 281.)

4. Suture the above flap in place making a columella out of the remaining portion with aid of the frontal flap extension.

5. Close the defect in the forehead as shown in Fig. 281, and cover any raw portions with skin graft of Thiersch or Wolfe.

6. After about ten days, sever the pedicle and implant properly, reconstructing the skin over the root of the nose.

Nélaton's Operation for Subtotal Loss of Nose.

1. An incision in the form of an A is made, the apex of the A coming close to the hair line (Fig. 282) and continuing laterally to the nasal defects.

2. By means of a fine saw the skin and underlying bone of the frontal nasal and superior maxilla are taken along in the shape of a triangular flap (Fig. 283), leaving the attachments at the alæ.

3. It is then bent into the shape of the tip of the nose point and folded so that the uppermost point of the flap comes in between the eyebrows. (Fig. 284.)

4. Suture in this position. (Fig. 285.)

5. Close forehead defect by sliding flaps.

Von Langenbeck's Operation for Collapsed Nose; Making Supports, Especially When Soft Parts Are Wanting (Osteoplastic).

1. An incision is made on the side of the nose from the nasal process of the frontal bone to the floor of nose. (Fig. 286.)

2. Dissect the skin laterally so as to expose the apertura pyriformis and the bones that are to be employed, namely, nasal bones and the nasal process of the superior maxilla.

3. With a small saw or chisel cut from above downwards a small strip of bone on each side of the margin of the apertura in such a manner as to leave its lower attachment at the superior maxilla. (Fig. 286.)

4. Elevate these two pieces of bone outward and bring over them the previously dissected skin which is further sutured to these bone particles. (Fig. 286.)

Fig. 282.

Fig. 284.

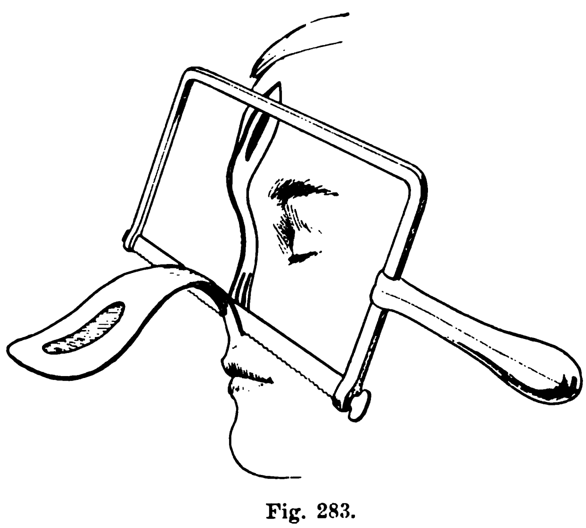


Fig. 283.

Fig. 285.

Nélaton's operation for subtotal loss of nose.

5. A similar procedure is practiced on the nasal bones, which are usually depressed. They are sawed or chiseled off from the nasal processes of the superior maxilla and elevated, leaving their attachment with the frontal bone as a sort of hinge. (Fig. 287.)

6. Form a proper forehead flap and cover this newly-made bony support, and suture in the usual manner.

Schimmelbusch's Operation for Total Loss of Nose.

1. Cut out a rhomboidal-shaped flap from the forehead with the broad part above, measuring 2 to 3 cm. between the margins below and 6 to 7 cm. at its upper part. Its length should depend on the length of the nose to be covered. This incision includes the periosteum.

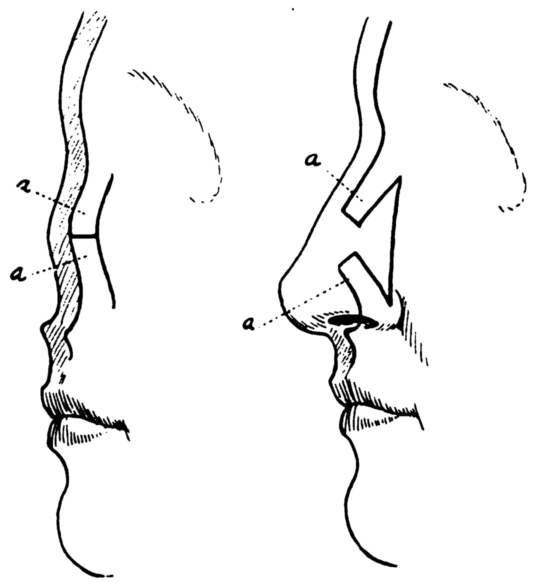


Fig. 286. Fig. 287.

Von Langenbeck's operation for collapsed nose; making supports, especially when soft parts are wanting.

2. By means of a broad chisel a thin plate of bone is taken away with this flap; in most instances it will be in several pieces, although endeavor should be made to keep the periosteum attached. (Fig. 288.)

3. Turn this skin-bone flap down and in order to prevent these bone plates from falling off, a sort of lattice work of silk thread should be passed about this flap and covered with gauze to allow granulation to form.

4. Cut out two curved skin flaps as shown in Fig. 288, to allow the sliding forward of the lateral skin flap for the closure of the frontal defect.

Fig. 288.

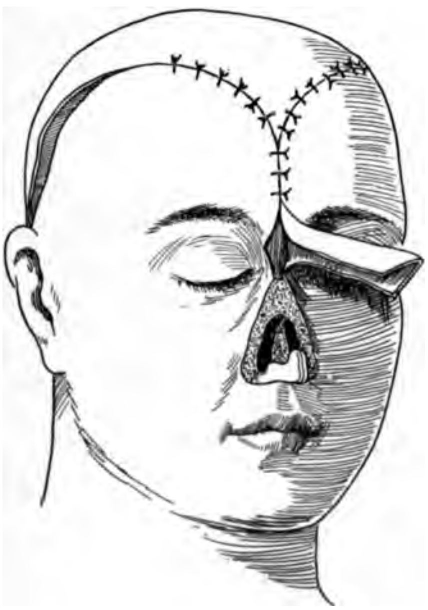


Fig. 289.

Fig. 290.

Schimmelbusch's operation for total loss of nose.

5. Continue incision up to the periosteum in a curvo-linear manner back of the ear and loosen the entire lateral flap. (Fig. 289.) This is done on both sides.

6. Slide the two lateral flaps so as to make them meet in the center of the forehead and also join the skin where the two little flaps were removed. As a result there will be two small defects on the side of the head, which can be allowed to granulate and can be corrected subsequently.

Four to Six Weeks Later.

7. By means of a saw divide the bony portion of the nose to be formed, and shape it in the form of a trough. In the event that the pedicle is again adherent at the root of the nose, it should be thoroughly loosened and the flap turned with its dermal surface outward. (Fig. 289.)

8. To form the columella, dissect off from each side of the pyriform aperture two skin flaps and unite them as shown in Fig. 289. This will leave their pedicle attachment at the usual insertion of the columella and their free end is to be attached to the newly-formed tip of the nose.

Three Weeks Later.

9. Freshen up the lateral portion of the defect, especially at the apertura pyriformis and dissect away the skin so as to lay bare the bony margins of the defect. The good result of this procedure depends upon this, since the implantation of the bony portion of the new nose on a raw and bony area makes a substantial support. Sutures through the bone are additional supports for good union.

10. Pass a wire through the lower portion of the nose, transversely, and fix by two small rolls of gauze or small rubber tubing so that the wire does not cut in. The purpose of this wire is to insure a roof-like form to the bridge of the nose. (Fig. 290.)

11. Sever the pedicles of the frontal flaps of the nose and place them into the defect where the two lateral flaps join in the middle of the forehead. (Fig. 290.)

Schimmelbusch's Operation for Saddle-back Nose.

1. Prepare the frontal (skin-bone) flap in the same way as in the Schimmelbusch operation for total loss of nose, and make the lateral flap in the same manner, uniting the created defect newly-formed in similar manner.

2. Turn the frontal flap directly down without twisting the pedicle, that is, the skin downward and bone externally, cover the flap with

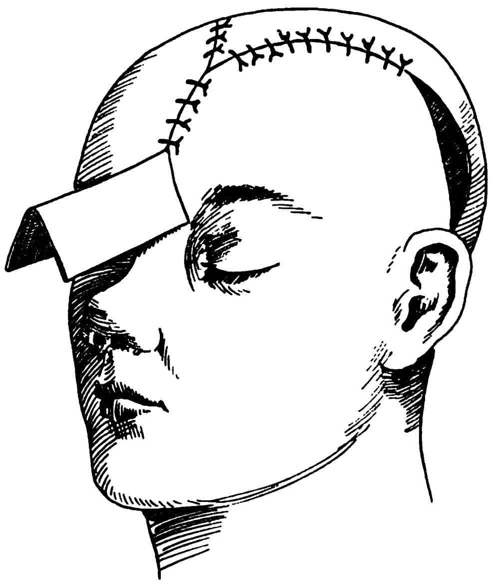


Fig. 291.

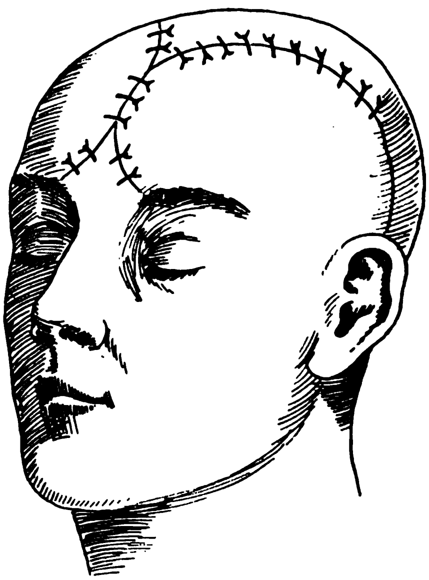


Fig. 292. Fig. 293.

Schimmelbusch's operation for saddle-back nose.

the thread lattice work to prevent the dislodgement of the bone and wrap the whole flap in gauze to allow the bone to granulate.

One Week Later.

3. Make a vertical incision in the middle of the bridge of the nose and cut loose subcutaneously the lower part of the cartilaginous portion of the nose, so as to bring down the tip, making an opening into the nasal cavity with the nostrils looking downward. (Fig. 291.)

4. Freshen up the bony apertura pyriformis and dissect the skin freely from the side of the nose.

5. Saw and break the bony portion of the frontal flaps in such fashion as to give a roof-like appearance. (Fig. 291.)

6. To insure healing, trim off the dermal layer of the frontal flap where it will come in contact with the tissues about the apertura pyriformis.

7. Place the frontal flap in position between the dissected lateral skin margins of the nose and firmly against the apertura pyriformis, where an anchor suture may be placed and brought out at the outer corner of the alæ. (Fig. 292.)

One Week Later.

8. Sever the pedicle at the root of the nose in such a manner as to utilize as much of the turned over skin as possible to fit into the still remaining defect between the eyes, where the two lateral parietal flaps come together, and then suture.

9. Freshen up the lateral skin margins of the nose and bring together over the middle of the nose. (Fig. 293.)

Sir Watson Cheyne's Operation (Indian Method).

1. An incision is made in the median line of the nose over the cartilaginous portion. (Fig. 294.)

2. Two transverse incisions are made at each end of the first incision, forming two lateral flaps when dissected, like an open door. (Fig. 294.)

3. Dissect these lateral flaps and take along any fragments of nasal bones or periosteum that may be attached to them. (Fig. 295.)

4. Sever the cartilage from the bony portion of the external nose and cut into the septum so as to pull down the point of the nose in the proper shape.

5. Two vertical incisions are now made slightly above the root of the nose and about one-eighth of an inch from the median line, as far up as the line of the hair. A third transverse incision unites these

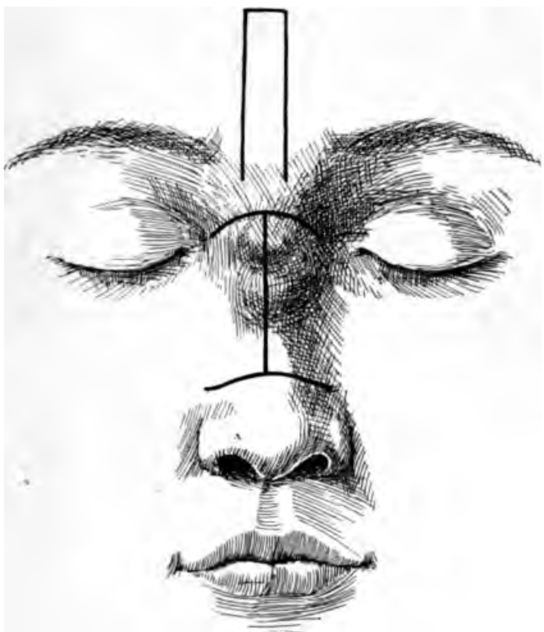


Fig. 294.

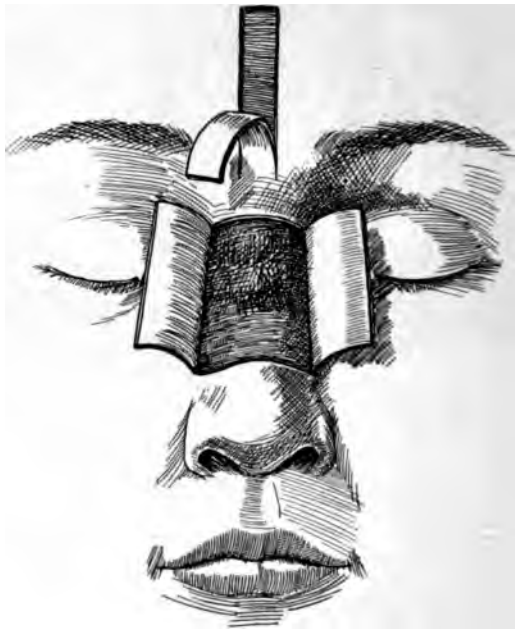


Fig. 295.

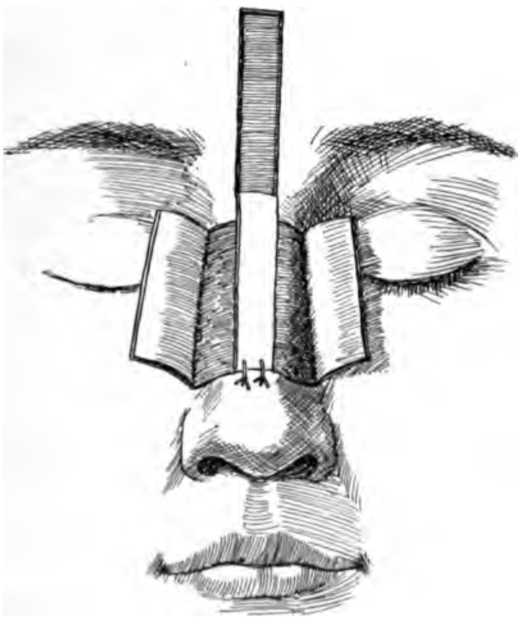


Fig. 296.

Fig. 297.

Sir Watson Cheyne's operation. (Indian method.)

two vertical ones at the hair line. These three incisions divide all the structures down to the bone. (Fig. 294.)

6. Insert a narrow chisel along the margin of these three incisions and separate a portion of the external table of the frontal bone, leaving it attached to the periosteum and the remains of the flap. (Fig. 295.)

7. This whole flap is now turned downward so that the skin is looking into the nasal cavity while the outer surface comprises the denuded bones.

8. Shave off the epidermis at the root of the nose as well as at the uppermost portion of this turned down flap so that these two may adhere at this point.

9. Suture the lowest point of this turned down flap to the freshened cartilaginous portion of the nose that was pulled down, thus closing the nasal defect. Care should be exercised at this point not to bend the upper pedicle too acutely and not to have any tension whatsoever. If there be trouble of this sort, two little incisions may be made on the side of the nose from the base of this flap and the tension thereby relaxed. (Fig. 296.)

10. Unite the defect on the forehead.

11. The lateral flaps are now replaced and united over the raw bony surface of the forehead flap, also above and below. (Fig. 297.)

Two or Three Weeks Later.

12. The pedicle is cut, turned back to fill up the defect and any irregularity trimmed down and corrected; any granulating surface may be covered by skin graft.

Von Hacker's Operation (Indian Method).

1. Outline the usual flap from forehead with pedicle at the root of the nose.

2. Dissect the skin on the three free margins of the flap to a point in the median line measuring 8 mm. in width and the full length of the flap; this portion is to form the subsequent bony support of the newly-formed nose.

3. The dissected skin is now sutured temporarily in the median line by two or three interrupted sutures and a few small pins driven into the bone-periosteal flap (Fig. 298) in order to facilitate its dissection.

4. By means of a chisel this bone-periosteal skin flap is now severed up to the root of the nose, where the pedicle only consists of **skin and** periosteum, in order to be able to twist it easily. (Fig. 299.)

Fig. 298.

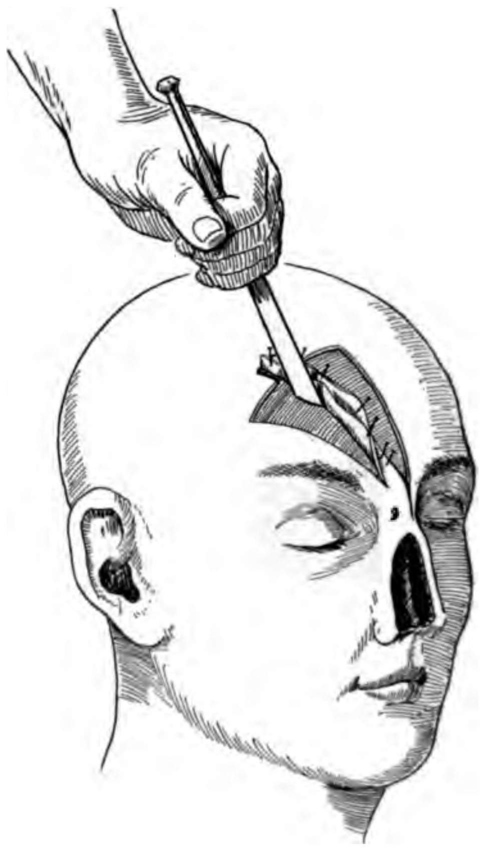


Fig. 299.

Fig. 300.

Von Hacker's operation. (Indian method.)

5. Break away the entire flap and rotate downward into the proper position, having previously prepared the defect for union by freshening up the margins and the remains of the septum with which the bony bridge is to come in contact. This bony strip is broken at the lower portion and a proper point of the nose is formed. It is sutured into the floor of the nose and a columella and alæ are formed from the skin flap. Rubber tubes are inserted into nostrils to give shape to them. (Fig. 300.)

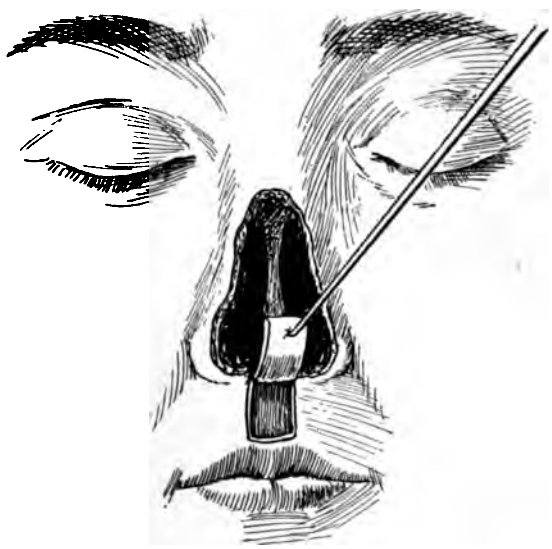


Fig. 301.

Fig. 302.

Sedillot's operation for total loss of nose. (Indian method.)

Sedillot's Operation for Total Noss of Nose (Indian Method).

1. Form a tongue-shaped flap from the upper lip, not going through the mucous membrane, placing the pedicle at the nasal floor. (Fig. 301.)

2. Form a forehead flap, taking care to make a longer median flap for the formation of the columella.

3. Freshen up the nasal defect.

4. Bring down frontal flap and suture in laterally, and to form the columella suture central flap to the little flap from the lip in such a manner that there is skin surface externally as well as in the nose; in other words, one on top of the other. (Fig. 302.)

IV. Double Transplantation Method.

A skin flap may first be made from the chest or abdomen and attached to a part of the hand or forearm, and after it has healed on and

good circulation has been established, it is severed, and then attached to the nose as in the Italian method. Or a toe from which the nail has been removed is implanted into the palm of the hand, and after it is thoroughly healed it is severed and made ready to use in constructing a firm support for a nose. Bone which has been removed from an amputated leg and formed in the shape of a nose, implanted under the forearm below the periosteum of the ulna, is prepared in the form of a pedicle after it has united and remained viable and is then sutured into a nasal defect, as in the Italian method. A similar method is em-

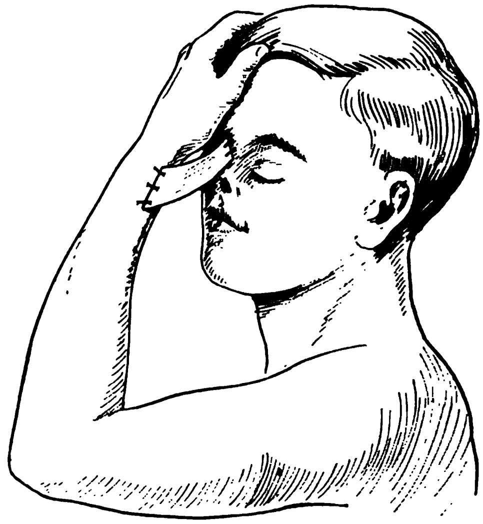


Fig. 304.

Fig. 303.

Steinthal's operation for total loss of nose. (Double transplantation method.)

ployed in implanting pieces of cartilage under the skin and periosteum of the forehead before making the frontal flap.

Steinthal's Operation for Total Loss of Nose.

1. Make a tongue-shaped flap from the sternal region with its pedicle towards the sternal notch, measuring 5 cm. at its free end and 3 cm. at the pedicle end, the length being about 12 cm. The flap is composed of skin and periosteum. Suture the defect over sternum in part.

2. Make an incision through the skin of the forearm near the wrist and over the radius to accommodate the free end of the above flap.

3. Suture in this free end of the flap for subsequent transplantation. (Fig. 303.)

4. Apply immobilizing plaster of Paris jacket.

Twelve Days Later.

5. Sever pedicle from sternum and leave it unattached to allow perfect circulation to be established in the flap for two or three days.

Fig. 305.

Fig. 306.

Kausch's operation for collapsed nose. (Double transplantation method.)

6. Freshen up the surface at the nasal defect.

7. Suture free end of flap situated on the forearm to this prepared surface about the nasal defect. (Fig. 304.)

8. Apply again a retention plaster of Paris jacket for about one week or ten days.

9. Sever the flap from the forearm and suture in about the remaining nasal defect to form a properly shaped nose, including columella and alar skin lining.

Kausch's Operation for Collapsed Nose.

1. Remove the nail of the fourth toe of the same side as the hand that is to be employed. A portion of the skin from the tip of the toe is turned back to obtain a good raw surface.

2. Make an incision in the thenar eminence of the palm of the hand of a proper size to accommodate the tip of the toe.

3. Bring hand and toe together approximating the tip of toe to the incision and suture well on all sides of the skin.

4. Place a retaining device either of plaster of Paris or leather to keep the parts immobile.

Two Weeks Later.

5. Sever the toe at the metatarsophalangeal joint, leaving it attached to the hand. (Fig. 305.) Close defect in the foot.

Two Days Later.

6. Freshen up the bony surface at the floor of the nose and the skin on the side of the nasal defect.

7. Bring hand in proximity to nose and suture the free end of the transplanted toe, which has also been freshened on, into the bone exposed at the prepared nasal defect. (Fig. 306.)

8. Retain by plaster of Paris bandage as in the Italian method.

Two Weeks Later.

9. Sever the attachment of the toe to the palm of the hand and close this temporary defect.

10. Remove the skin from transplanted toe from the part that is to come in contact with the subcutaneous tissue of the ridge of the nose. If the mass of bone is too large one may bite out a portion and also shape it in the form of a columella and ridge, giving the nose a proper shaped point. Suture the distal end towards the root of the nose.

11. Subsequent smaller corrections of making proper shaped nostrils, etc., should be done not before two weeks, when the circulation is well established.

V. Finger Method.

In cases where a greater part of the bony portion of the external nose is absent and most of the soft parts, the employment of the finger, sacrificing this member for the formation of a nose, has been followed by good results. The cases especially suitable for this operation are those in which the greater part of the alæ and probably the skin portion of the tip of the nose are still present, even though this latter portion be markedly drawn in and adherent.

Watt's Operation for Subtotal Loss of Nose.

1. Sever the columella at its attachment to the upper lip.

2. Take the left little finger and remove its nail and matrix, also the skin from its tip anteriorly.

3. Pass this finger through remnant of tip of nose and fix at the root of the nose close to the frontal bone by means of silver wire, an area having been prepared in this region. (Fig. 307.)

4. Apply a plaster cast to hold parts immobilized in place.

Two Weeks Later.

5. Amputate finger at metacarpophalangeal joint and close defect in hand.

A Few Days Later.

6. Trim down the free end of the finger so as to make it narrow enough to obtain two separate nostrils.

Fig. 307.
Watt's operation for subtotal loss of nose.

7. Push this end of the finger into the nasal cavity and fix by another suture.

8. Suture back the previously severed columella to the lip by refreshing their surface.

One Week Later.

9. Remove skin from dorsum of the now healed-in finger at the nasal defect.

10. A flap from the forearm is made and sutured in above the defect, fixed again by plaster jacket and treated as in any Italian method.

Fig. 308.

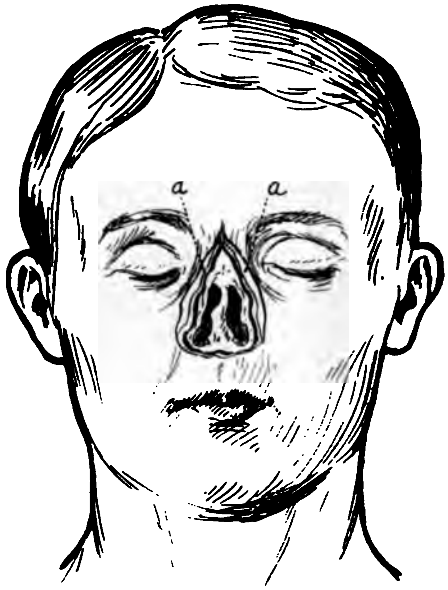


Fig. 309.

Fig. 310.

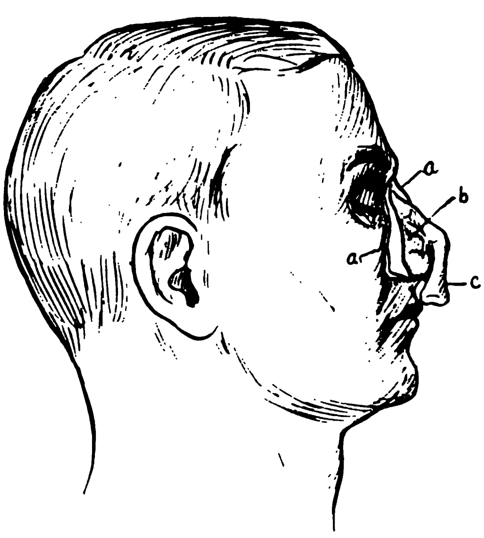


Fig. 311.

Wolkowitsch's operation for total loss of nose. (Finger method.)

Wolkowitsch's Operation for Total Loss of Nose (Finger Method).

1. Take the fourth finger of the left hand.
2. Make a median incision over the dorsal surface of the same from the metacarpophalangeal joint to the nail, through the skin and subcutaneous tissue.
3. Dissect loose to either side freely.
4. Remove the nail and be sure of the removal of all of its matrix. Tendon must not be disturbed. (Fig. 308.)
5. Remove the skin from the tip of the finger in front for its attachment at the root of the nose.
6. Split the skin and underlying tissues through to the bone in the median line at the root of the nose, and separate freely to either side, including the margins of the remaining apertura pyriformis.
7. In the bony structures at the root of the nose make a dent by means of a gouge, into which the tip of the finger will fit so as not to make a perceptible hump at this point. (Fig. 309.)
8. Bring the finger to the prepared area of the nose and tuck its skin flaps below the dissected lateral flap about the apertura pyriformis, the tip of the finger being fitted into the depression at the root.
9. Fasten the finger at the root by sutures, as in Fig. 310, and stitch the skin flaps of the finger, which are tucked under the dissected skin of the nose defect, with two mattress sutures on each side.
10. Close the median incision at the root of the nose as far down over the finger as possible.
11. Place a quantity of marly (Scotch gauze) below the finger to hold it up in the shape of a nose and place a dressing over the surface. Then apply a fixation bandage as in any Italian operation.

Nine Days Later.

12. Remove the stitches and extend the incision over the dorsum of the hand so as to expose the entire metacarpophalangeal joint for excision.
13. Dissect the skin laterally and incise it on either side of the finger, but do not sever in front at this time.
14. During the next five days in two separate sittings the skin pedicle is severed and the metacarpophalangeal joint disarticulated.
15. Cover the defect on the hand as in a regular disarticulation operation by the remaining skin anteriorly.
16. Bend and shape the now attached finger in the form of a nose, place some more marly below it and allow it to remain for three more days for firmer attachment. (Fig. 311.)
17. Bend sharply between the first and second phalangeal joints

Fig. 312.

Von Esmarch's operation for collapsed nose or absence of the premaxilla or an anterior perforation of hard palate.

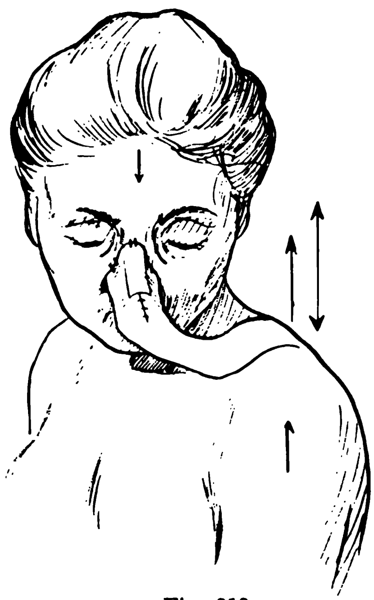


Fig. 313.

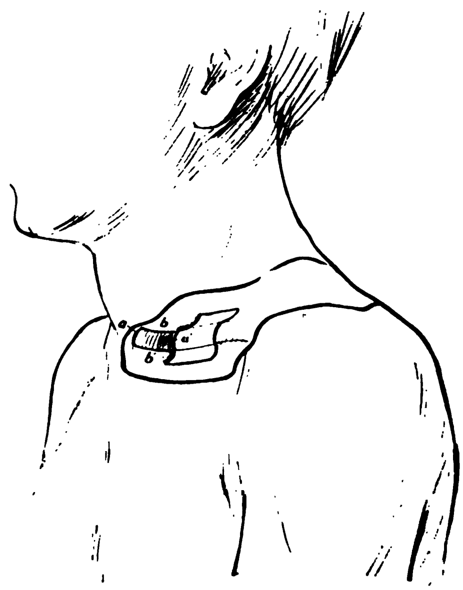


Fig. 314.

Clavicle method. (Gustav Mandry.)

to such a degree that the first phalanx may be pushed into the nasal cavity.

18. Prepare the floor of the nose and if there is a portion of septum remaining, remove all the mucous membrane and expose its bony surface.

19. Remove all the skin and granulations from that end of the finger that has been disarticulated and push it into the nose against the raw surfaces prepared at the floor.

20. Dissect now the lateral margins of the apertura pyriformis low down to where the alæ are to be formed, and tuck under the remaining portions of the skin flap of the finger, which are again attached by one mattress suture on each side.

21. Cover the entire denuded surface of this bony reconstructed framework with a Krause flap or with any flap either from the forehead or arm. Further slight corrections, as formation of nostrils and cover for columella, are subsequently performed.

Von Esmarch's Operation for Collapsed Nose and When There Is Also Absence of the Premaxilla or an Anterior Perforation of Hard Palate.

1. Remove the nail of the little finger of the left hand and freshen up the tip anteriorly.

2. Freshen up the surface on the inner side of the tip of the nose and what is still existing on the floor of the nose anteriorly. If nose is retracted, it should be freely dissected and made movable.

3. Fasten the finger with wire to the bone of the superior maxilla about the defect and stitch to the soft part of the nasal tip. (Fig. 312.)

4. Apply a plaster jacket.

Two Weeks Later.

5. Disarticulate, usually at the junction of the second and first phalangeal joint.

Two or Three Days Later.

6. Freshen up the margins of the perforation or defect at the roof of the mouth and suture in the properly prepared stump of the finger.

VI. Clavicle Method (Gustav Mandry).

1. Form a flap over the region of the clavicle, consisting of skin and subcutaneous connective tissue and of the periosteum and bone of the clavicle. The broad pedicle is situated over the shoulder and the free end at the **sternoclavicular articulation**. (Fig. 313.)

2. Dissect this skin flap up to the upper and lower margins of the clavicle, leaving it here attached to the bone.

3. Chisel or saw out a sliver of the clavicle measuring 4.5 cm. long by 0.5 cm. wide (indicated by a-a^1-b-b^1—Fig. 313) near the sternoclavicular articulation without detaching the skin and periosteum.

4. In the free end of this sliver two small holes are bored for subsequent anchorage to the nose.

5. In the middle of this large flap, right over the clavicle, a flap of skin and subcutaneous tissue is made in the form of a window, directing the pedicle towards the sternoclavicular articulation, in order to turn it on the under surface of the bone sliver, in that way assuring its nourishment from both sides, besides subsequently forming a dermal lining for the interior of the nose. This central flap is turned 180 degrees and made to come beyond the terminal end of the bone sliver, where it is fastened with the skin above, thus surrounding this bone.

6. Close this newly-formed central buttonhole in the large flap by a few interrupted sutures. (Fig. 314.)

7. Allow this whole flap to rest over its dissected area where it will attach itself temporarily, getting additional nourishment for its sustenance.

Four Days Later.

8. Separate this whole pedicle, including the double skin covered bone sliver, and liberate it more freely by commencing the outside incision over the shoulder and back, thus giving a greater motion to the flap for its adaptation to the nose region.

9. Freshen up the nasal area, making a pocket at the root of the nose in which the clavicular bone sliver will be slipped.

10. Expose this bone sliver and place two strong sutures through the holes which have been previously drilled.

11. Turn the head towards the shoulder where the flap is formed, and bend it slightly downward so that the flap can be brought in close approximation with the nose without any tension.

12. Bring the two strong sutures through periosteum and skin at the root of the nose and tie over a pad of gauze, fixing the bone sliver in the newly-formed pocket.

13. Apply a few additional sutures at the top and side of the nose. (Fig. 314.)

14. Fix the head in the twisted flexed position in a plaster cast, as in the Italian operation, and provide proper windows in the cast for feeding and for dressing of the wound.

One Week Later.

15. Sever the bridge pedicle at the place where it is decided that proper skin flaps may be made to complete the alæ, columella, etc.

16. Dissect off the epidermis laterally from the flap and freshen up the margins of the apertura pyriformis so as to obtain proper union.

17. Expose the end of the transplanted bone sliver and eventually fracture it so as to make a tip of the nose.

18. Freshen up an area of the bone at the floor of the nose just in front and suture in this free end of the bone sliver.

19. Cover this by the newly-formed columella.

20. Turn in the redunant skin flap at the alar region to line the newly-formed nostrils and put in two small rubber tubes.

21. Readjust the shoulder flap and cover the newly-formed bone defect with it as nearly as possible; what remains may be covered with skin graft or allowed to granulate.

22. Subsequent correction on the nose may be necessary.

VII. Implantation Method.

Aside from the very popular and successful method of injecting paraffin, many varieties of implantation operations were formerly performed for the correction of defects or malformations. Gold, German silver, filigree wire, hard rubber, etc., have been generally abandoned for newer and better methods, inasmuch as these foreign bodies very frequently, after healing in beautifully, became the seat of irritation which necessitated their removal. The implantation of a sliver of the anterior border of the tibia was successful in one case of the author's; in another it became necrotic and removal was required. Senn employed decalcified bone chips in some cases of saddleback nose. Recently the author removed a septum by submucous resection, allowing one layer of perichondrium to be attached and placed it in a dissected pocket of a saddleback nose of another patient. This healed in very beautifully and resulted in success.

In another case three different implantations were made into collapsed alæ which healed in, but appeared to have become absorbed.

Another method advocated recently is to implant a mass of fat from a patient upon whom a laparotomy is performed, into a dissected pocket of a saddleback nose. The author has tried this method in one case and it appears that the fat tissue remains alive. The one difficulty is that the nose looks very large for a time as a great amount of fat is used to fill up the defect, in order to anticipate the absorption or shrinkage of the mass.

The employment of a sliver of bone from the anterior border of the tibia or a part of a rib is a method that has many advocates.

Israel's Operation for Saddle-back Nose.

1. Make an external incision 2 cm. long over the saddle and dissect to all sides subcutaneously, until by pulling on the tip of nose the appearance is normal. Close this external incision.

2. A piece of bone 3 cm. long from anterior border of tibia is chiseled off and formed into sharp points on either end.

3. From the interior of the nose the previously dissected tunnel is found by means of a dissection and the sliver of bone is introduced in this direction, the upper end of the bone fragment coming in contact

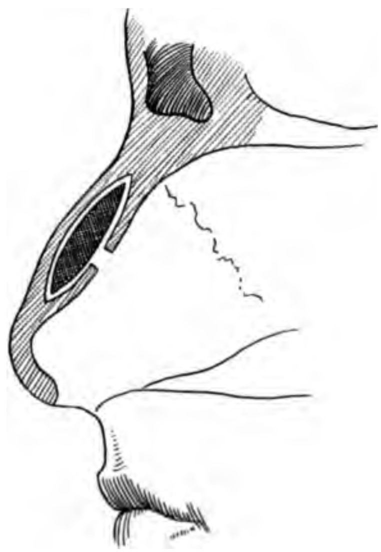


Fig. 315.
Israel's operation for saddle-back nose.

with the nasal bones, the lower at the tip between the external skin and the lining of the vestibule. (Fig. 315.)

Goodale's Operation for Depressed Nose. (Fig. 316.)

Modified by Watson-Williams.

1. The mucoperichondrium is dissected over the entire cartilaginous area on both sides and pushed up and back.

2. Loosen up the tissue below the depression intranasally.

3. Cut out a flap of cartilage with its loosely adherent pedicle towards the depression. (Fig. 317.)

4. Slide this cartilage flap below the depression and bring down the mucoperichondrium into its original position. (Fig. 318.)

Fig. 316.

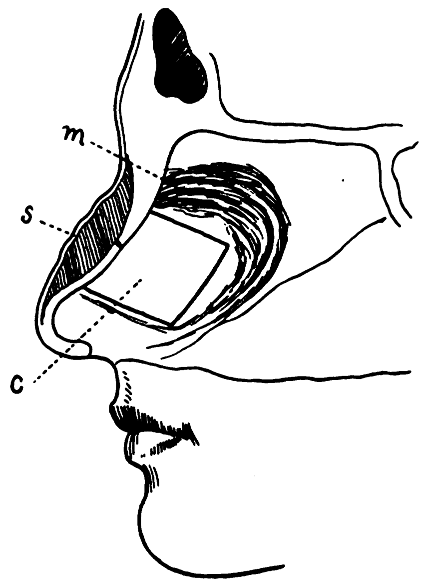


Fig. 317.

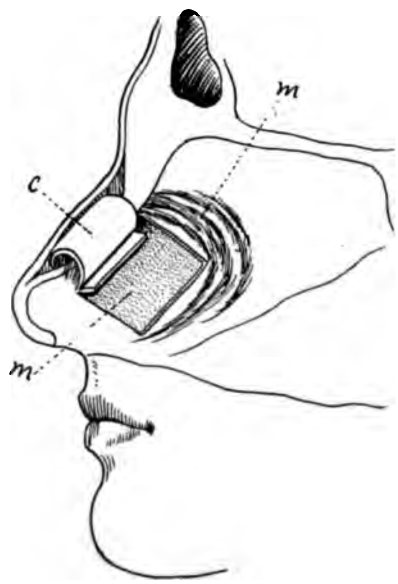


Fig. 318.

Fig. 319.

Goodale's operation for depressed nose.

5. Hold by transfixing gold-plated pins for three weeks.

The writer suggests silk worm gut suture tied over rubber tubing or gauze. (Fig. 319.)

Ouston's Operation for Depressed Nose Below the Bridge.

1. Separate the cartilaginous portion of the depressed nose subcutaneously from the nasal bones and nasal process of superior maxilla

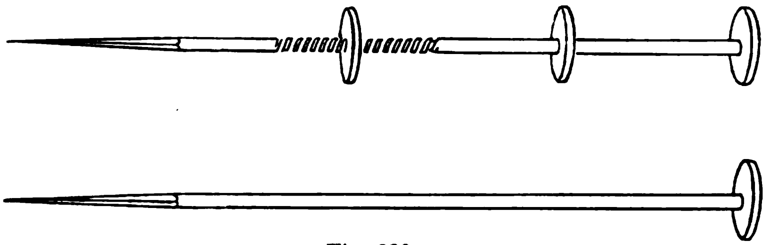


Fig. 320.

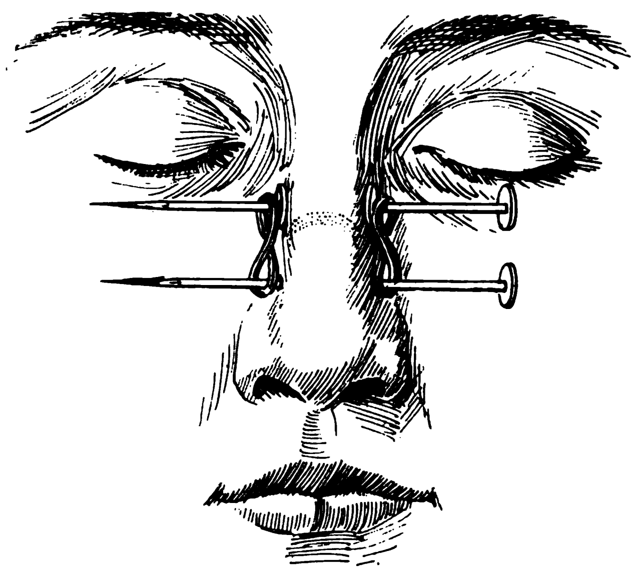


Fig. 321.

Ouston's operation for depressed nose below the bridge.

on either side; also sever the cartilaginous septum, the incision being made latterly lengthwise.

2. Transfix all these cartilaginous structures with one of Ouston's needles (Fig. 320), just below the nasal bones.

3. Pass another needle through the nasal bones which serve to support and lift the loosened cartilaginous portion of the nose.

4. Wind a thread or gauze in the form of a figure eight (8) from the upper to the lower needle while the loosened cartilaginous portion of the nose is held up. (Fig. 321.)

Carter's Operation for Saddle-back Nose.

1. By means of a large curved needle, which is threaded with No. 14 silk, one of the hard rubber splints is anchored. (Fig. 322.)
2. Pass the needle from within outward at the junction of the cartilage and nasal bone, just at the middle of the dorsum. (Fig. 323.)
3. Repeat the first step on the other side of the nose. (Fig. 323.)
4. Apply the metal (Carter's) bridge and set it by means of the thumb screw so that it fits firmly at the base of the nose. (Fig. 324.)

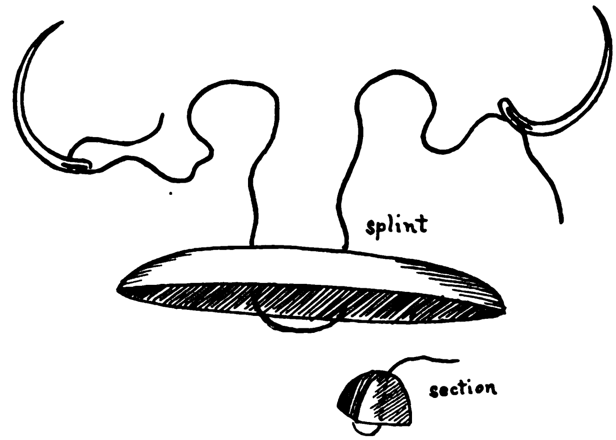


Fig. 322.

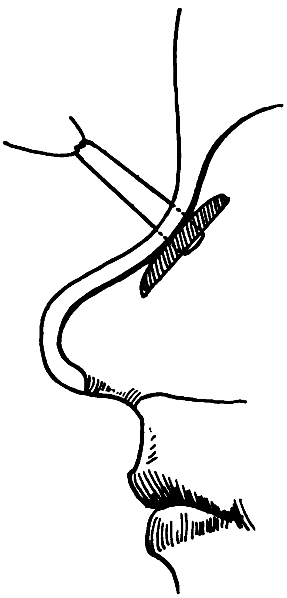


Fig. 323.

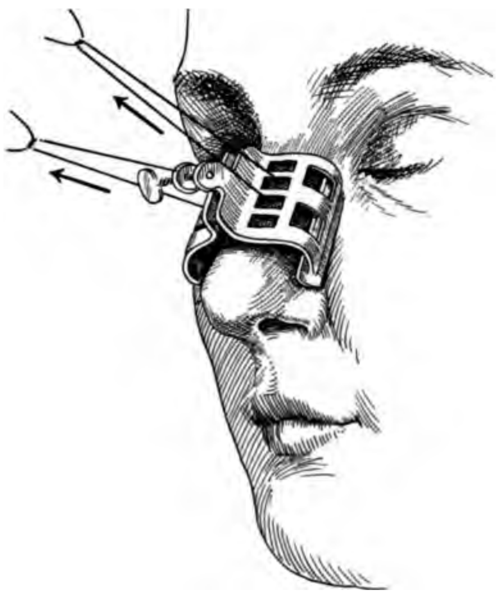


Fig. 324.

Carter's operation for saddle-back nose.

5. Draw firmly upward on the two threads so as to raise the flat or depressed nose and tie them over the hinge of the bridge. (Fig. 324.)

If the tissues are fixed or if it is impossible to lift the nose by the threads, it may be necessary to loosen the nasal bones from the nasal process of the superior maxilla by means of chisels and forceps and then by fracturing. The septum of the nose may at times be so short as to necessitate incision. This treatment is best carried out with the patient in the recumbent position, but by employing adhesive

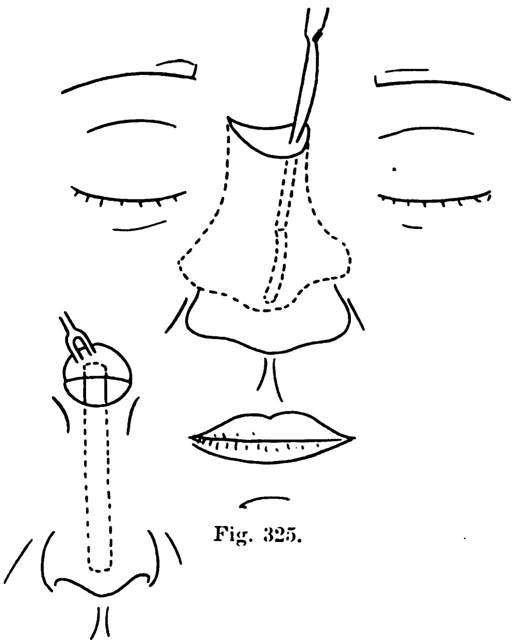


Fig. 325.

Fig. 326.

Carter's operation for saddle-back nose.

plaster the bridge may be fastened to the forehead and then the patient may be allowed to walk or sit up. This bridge is allowed to remain in position from ten days to two weeks. Cleansing the interior of the nose with Dobell spray is advised.

Carter's Operation for Saddle-back Nose (No. 2).

1. Make a curvilinear incision to the periosteum from one eyebrow to the other, with convexity of the incision downward. (Fig. 325.)

2. Lift the skin flap and make transverse incision through the periosteum into the bone.

3. Elevate the periosteum upwards for three-eighths of an inch.

4. Elevate the skin and subcutaneous tissue over the dorsum of the nose and side of the cheeks as far as the deformity exists.

5. Remove a strip of the ninth rib, with periosteum, about two inches long and split it transversely so as to shape it to correct the deformity.

6. Scrape the cancellous tissue off the bone.

7. Without removing the blood from the prepared pocket, insert the bone graft as far down the tip of the nose as necessary and place the upper end well under the periosteal flap. (Fig. 326.)

8. Close the skin flap with horse hair sutures.

9. Apply collodion dressing.

Beck's Method for Saddle-back Nose.

1. Lift up tip of the nose and make a small semicircular incision in the anterolateral portion of the vestibule at the mucocutaneous junction of the cartilage and bone.

2. With Mayo's scissors dissect over the hump as in Fig. 326. With the same scissors engage and sever the hump which is usually made up of cartilage.

3. Employ a portion of the rib, the anterior surface of the tibia, or a portion of the septal ridge, from the patient himself or from another patient who has just been operated on for submucous resection. The size of the bone splinter should correspond to the size and shape of the deformity to be corrected.

4. The blood expressed from the cavity is mopped away and an adhesive plaster is drawn tightly over the bridge of the nose with no dressing between it and the skin.

5. One silk stitch closes the wound.

Walshaus' Operation for Collapsed Alæ.

1. Make a flap of the mucous membrane of the most anterior portion of septum, one-eighth of an inch wide and one-half of an inch long, leaving the pedicle at the dorsum of the nose. (Fig. 327.)

2. Roll up this mucous membrane flap and fasten in the upper angle of the nostril. (Fig. 327.)

3. Repeat the same on the opposite nostril.

Lambert Lack's Operation for Collapsed Alæ.

1. Remove a strip of mucous membrane from the right side of the most anterior portion of the septum, measuring about one-eighth inch wide and one-half inch long.

2. Cut through the cartilage and mucous membrane into the left nostril corresponding to the defect, leaving, however, the flap intact at its hinge pedicle at the dorsum of nose.

3. Denude the surface of its mucous membrane where the septum and lateral cartilage of ala come together; also of the dermal layer of the inner side of the ala.

4. Turn the cartilage mucous membrane flap up in the right nostril placing the two denuded surfaces together.

5. Make a similar flap back of this one, only reversing the denudation on the septum.

6. Turn this flap into the left side and fix to a similarly denuded surface of the ala, only further back. (Fig. 328.)

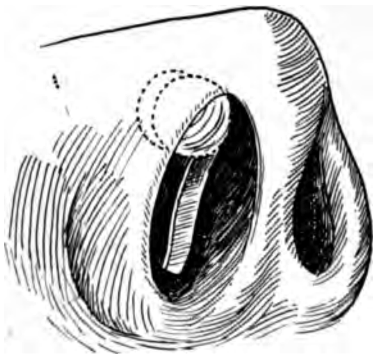


Fig. 327.

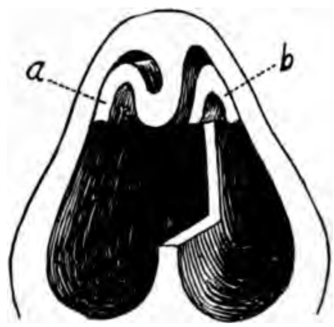


Fig. 328.

Walshaus' operation for collapsed alæ.

Paraffin Injections in Nose and Ear Deformities.

The history of this means of correcting nose and ear deformities dates back to 1900, when Gersuny corrected a saddle-back nose by the use of melted vaselin, injecting it below the skin. Eckstein in 1901 employed hard paraffin which has a melting point of 140° F. for similar defects, and claimed for it superiority in that there was less chance for pulmonary embolism. This method was very warmly received and employed by Broeckaert, Brindel, Karenski, Lake, and others abroad and by Harmon Smith, Kolle, Quinlin and others in the United States.

The principal indication for paraffin injection is deficiency of tissue about the nose or ears, since excessive growth or absence of tissues of the external nose and ears are not within the limits of this method of treatment. Frequently there are post-traumatic or inflammatory conditions about the nose which leave scars and adhesions that will prevent proper injection of paraffin. In such cases, preliminary dissection or loosening of these scars may be necessary. The introduction of a small quantity of paraffin after such dissection to keep the skin from readhering is good practice. Subsequently one may complete the

injection in one or more sittings. No anesthetic is required except in young individuals who would not remain quiet during the injection.

Many untoward results have been reported from the use of paraffin injection and according to Connell, who has gathered them from the literature, they may be grouped as follows:

1. *Toxic absorption or intoxication.*—This condition is most probably due to the impurities in the paraffin and not to the chemical absorption and reaction of the paraffin itself. Too large a quantity, about 1/10 of the body weight, would have to be injected before any toxic symptoms would be observed, according to Jukuff.

2. *Inflammatory reaction* when the proper technic has not been carried out, in injecting too large a quantity of paraffin at one time, or if the material contains any impurities.

3. *Loss of tissue* due to infection and secondary abscess formation has been observed to follow these injections when the usual aseptic precautions which are expected to be carried out in any surgical operation have not been observed. Instruments, the field of operation, and the material itself must all be sterile. The skin offers the greatest difficulty, since there are constantly many varieties of microörganisms about the nose, alæ and vestibule, which are located in and incorporated with the sebum in the glands, and are very hard to eradicate. However, since tincture of iodin has been employed before operation for painting the area even without previously using any soap or water, there is less chance for infection after these injections.

4. *Pressure necrosis* will invariably follow when the paraffin is injected into the skin proper rather than subcutaneously. It will also follow when too great a quantity is injected at one time by shutting off the blood supply, with a greater chance for secondary infection. Again, it is essential to be most careful if there exists some constitutional disturbance or local devitalization of the tissues, such as results from scar tissue. Firmly bound down skin must always be first liberated before the injection of paraffin.

5. *Sloughing* has been reported, especially when the paraffin was injected while very hot. The author agrees with many operators that this is very unlikely, because by the time the paraffin is injected into the tissue it has cooled off to a degree approximating the body temperature. Since the hard paraffins (Eckstein 140°) are now employed, complication from this cause seldom occurs. Sloughing, however, does occur when the injection is made into the wrong place, as into the skin especially where it is firmly bound down naturally or by scars. This complication may be avoided by first making a subcutaneous injection of sterile or normal salt solution or by the subcutaneous dissec-

tion and an injection of three-fourths vaselin and one-fourth paraffin so as to prevent readherence of the dissected surface. An incision should be made and plates of paraffin or Cargile membrane introduced. Then injections are made small in quantity until the deformity is corrected. It is well to observe the general condition of the patient and in syphilitic cases a Wassermann reaction should always precede the injections to be sure that the blood is in good condition, even when the patient shows no active symptoms.

6. *Subinjection* or the injection of an insufficient quantity can scarcely be classed as an untoward result; it is only necessary to inject again. If subinjections were common, less disagreeable results would be reported.

7. *Hyperinjection* or the injection of too great an amount occasions the most disagreeable results met with in this procedure. This is especially true when this mass undergoes early organization. Under these circumstances its removal by surgical measures is required, since the various solvents, as ether, xylol, benzine, chloroform and heat have very little effect. Electrolysis, the negative pole being introduced into the mass, has been suggested as beneficial, but the author has found it of no value in a case of paraffinoma so-called, in which he employed this method. Instead of making external incisions the vestibule may be opened. It is well to remove the excess of paraffin just as soon as possible before organization has taken place.

8. *Air embolism* may occur, especially when cold paraffin is employed. In filling the syringe, the needle is as a rule obstructed and an air chamber remains between it and the paraffin taken from the glass tube. This should be avoided by completely emptying the syringe and needle before refilling and then forcing out fresh paraffin through the end of the syringe. If a small air bubble gets in below the skin it will do very little harm.

9. *Paraffin embolism* is of a more serious nature. In fact, it must be named as the most dangerous accident in connection with paraffin injections. There are several reports of death from this cause and many grave symptoms, as blindness, pneumonia and cerebral embolism, have been recorded. If the needle is introduced below the skin separately from the syringe and no blood allowed to escape then the immediate danger of embolism following the fragmentation of the paraffin is obviated. It is thought that these small particles getting into the circulation cause the trouble, but the explanation is more theoretic than real. After eight years of personal experience with paraffin in various methods and locations in a goodly number of cases, the

author cannot report a single instance or even a symptom referable to paraffin embolism.

10. *Primary diffusion or extension* of paraffin will occur especially after injecting for the correction of a saddle-back nose, when the needle point is allowed to go beyond the limits or after injecting a larger amount than one should, and especially when using liquid (hot) paraffin or vaselin. The loose areolar tissues of the lower lid, cheeks and eyebrows are the principal location for diffusion of the paraffin. By having the assistant hold his fingers firmly down on the bony structure over the root of the nose, as well as at its side, a great deal of this danger will be avoided. Semi-solid or cold paraffin practically makes this accident impossible. The author takes a piece of dental modeling compound and while warm and soft, molds it to fit the above named margins at which the assistant holds his fingers. This insures absolutely the retention of the paraffin within the limits of this mold, which when it cools becomes very hard.

11. *Interference with the action of the muscle of the alæ or wings of the nose.*—This is most likely to happen when a very low deformity of the nose is to be corrected. The author has found that the opposing muscles of the constrictors of the alæ cannot act and the patient then complains of nasal obstruction like that due to paralysis of the dilating or lifting muscle of the wings of the nose. In order to prevent the paraffin from coming down too far a finger should be inserted into the nostril during the injection and the tip of the nose raised upward and outward, if a lateral injection is made.

12. *Escape of paraffin* after injection can be avoided by thoroughly molding the mass into the desired shape, although this should be done even while the needle is still within the tissues so as not to get the mass into one place. The needle should be moved about, almost withdrawn, and reintroduced, since the paraffin often sticks to the needle. The needle should be withdrawn only after no more paraffin whatever is escaping from it. It escapes usually for a few moments even after the turning of the piston ceases on account of the pressure within the syringe. A fine blunt pointed probe should be passed through the opening of the skin so as to be sure that no paraffin is left in the skin puncture. A drop of collodion will further close the puncture and prevent the escape of any paraffin. Nasal motion or manipulation should be prevented. If liquid paraffin is employed under such circumstances cold applications for a few moments are advisable.

13. *Solidification of the paraffin* in the syringe, or more frequently within the needle, is a condition that complicates the technic

very much, especially when paraffin of high melting point is used. The injection must be accomplished quickly, frequently necessitating the heating of the needle over a flame just before introduction—a process which may be injurious to the skin. Again the sudden expulsion of the liquid paraffin into the tissues may cause it to pass into undesirable locations or too much paraffin may be injected at one time, causing all the complications of hyperinjections. The fact that semi-solid paraffins in the cold state are mainly employed now, makes this occurrence rare. It appears to the author that when the same syringe that is employed for the semi-solid paraffin is used, however, with a very short and conical needle, the solidification of the paraffin is obviated. By rapidly screwing the piston down, the injection can be more readily controlled.

14. *Absorption and disintegration* of the paraffin injected are of considerable interest and importance. Some authors believe that the injected mass becomes encapsulated by a fibrous capsule like a foreign body, while many others with histologically examined tissue as proof, believe that the mass is first surrounded with a connective tissue wall, and that fibrous bands traverse the mass and subdivide it. The paraffin finally becomes absorbed and all that is left is a new connective tissue mass of cartilage-like consistency to the touch. The ultimate absorption of the paraffin does not seem to have any effect on the general condition of the individual. The time required for the paraffin to become absorbed varies according to the kind of paraffin injected, the amount and location of the injection, and differs even in different individuals. Some authors have found that after one month a good-sized mass was entirely replaced by connective tissue, while others have found paraffin as late as four months after injection. The harder the paraffin the longer will it remain and the less will it be traversed by connective tissue. In loose connective tissue areas absorption will be more rapid than in closely bound down areas. Small quantities injected at a time will be absorbed more rapidly than larger. It is of interest to note the action of the newly-formed connective tissue as to absorption and contraction on taking on neoplastic manifestations.

15. *Difficulties as to the proper melting point of the paraffin.*—In this regard widely different opinions are expressed. However, the great number of operators believe that paraffins of lower degrees, melting point from 97° to 115° F., are the best for the purpose. The author believes that the formula recommended by Kolle:

Paraffin (plate sterile)............	ʒii
Vaselin (white sterile)...........	ʒii

is the best to employ. Glass tubes may be prepared sterile in advance and in these the paraffin may be resterilized, tube and all, just before the injection, by washing with bichlorid and alcohol. The injections should be made with this semi-solid paraffin in a cold state because the complications and unpleasant results may thus be avoided.

16. *Hypersensitiveness* of the skin plays a very small role in the objections or difficulties met with in the use of paraffin injections. Usually for a short time only, twenty-four to forty-eight hours after the injection is made, is there any complaint of pain. More often patients complain of a sense of distension or of a drawn feeling. Late symptoms rarely develop if cold paraffin is used in small amounts at a time and if some little time intervenes between the injections. Harmon Smith reports a sense of numbness following the injection and other authors have reported subsequent neuralgic pains from the sensory nerve filaments caught in the newly-formed connective tissue mass after the paraffin has become absorbed. If infections of the skin or subcutaneous tissue should take place following the injection, there may be some tenderness or hypersensitiveness of the area injected.

17. *Redness* of the skin is a pretty constant result of paraffin injections. It varies a great deal in degree, there being in some cases only a flush, while in others a very deep red color follows. Again it may simulate a grave acne rosacea, with distinct new blood vessel (capillary) formation. It may also appear at different times following the injection. Sometimes immediately after the injection has been made, especially if hot liquid paraffin is employed, the nose becomes very red and it may continue so for a long time. Again, the redness and capillary formation may not occur until months later. This appears to be due to hyperinjections, especially of hot material.

Redness is unquestionably due to pressure, on the venules such as one would obtain in Bier's hyperemia, and possibly to an active hyperemia, nature's part to assist in absorbing the foreign body, paraffin. Again, late appearance of the redness is very likely due to cicatricial subcutaneous contractions from the new substitute connective tissue mass. Whether the chemical action of the hydrocarbons has anything to do with the redness of the skin has not yet been determined. The early evidence of redness may be relieved by ice cold applications, moist dressings of acetate of aluminum, ichthyol salve, ten per cent extract of ergotol, belladonna, and adrenalin internally. In later stages the same treatment plus the eventual severance of newly-formed blood vessels, puncturing of the skin very superficially, and electrolysis have all been suggested. Early cases when very stormy and red, may call

for removal of some of the injected mass and older cases after all has been done, may require the dissection of some of the newly substituted mass of connective tissue. The author has found that a certain amount of redness follows these injections, but that it never lasts very long and eventually disappears.

18. *Secondary diffusion* of the injected paraffin has occurred a number of times, especially into the loose tissues of the eyelids. The difficulty lies in the fact that the paraffin is injected in areas tightly bound down, as the root of the nose, and finding a lack of resistance at this place it migrates into the looser areas. In all such cases the use of cold paraffin in small quantities will avoid this difficulty; when once diffusion or migration has taken place, excision is about all that can be done.

19. *Hyperplasia* of the connective tissue following the organization of the injected matter has been observed a number of times, and the author had a very pronounced case come under his observation, which is here illustrated (see Fig. 329). The specific cause of such new formation of connective tissue in this extensive form is not known, and most authors believe it to be due to a special predisposition on the part of the individual, such as is found in the tendency to develop keloids. When such a disfiguring condition develops there is only one procedure admissible—the complete excision of the fibrous mass. If there should be a recurrence, a second operation must be performed.

20. *Yellow appearance and thickening* of the skin after these injections are observed in rare instances, and they are among the most difficult conditions to deal with satisfactorily. The cause is supposed to be the use of hard paraffin injected too close to the dermal layer in regions where there is not enough loose underlying tissue. The electrolytic treatment, by making a number of punctures at repeated sittings, is advised. This will bleach the area by secondary scar formation and contraction. In case the result from such treatment is not satisfactory, it may be necessary to excise the pigmented portions.

21. *Breaking down* of tissue and resultant abscesses due to the pressure of the injected mass upon the adjacent tissue after the injection has become organized have been observed generally in cases following trauma. Abscess formation has been observed without this cause, and may be due to the increased pressure on the blood vessels, causing their obliteration and the breaking down of the tissues. The treatment consists in making a small incision and draining the accumulated purulent material. When all reaction symptoms disappear the parts are again injected.

Fig. 329.

Paraffinoma with attempted removal.

Technic of Paraffin Injections.—*Instruments.*—About all that is required is a syringe which is strong and not too heavy, with a screw or ratchet arrangement for expressing the paraffin slowly, but which can also be made to expel its contents in heated liquid form in a continuous flow. There are many varieties on the market, and those of Harmon Smith, Broeckaert, Eckstein, Kolle, Onodi, Walker Dowman and the author's are all satisfactory. The only difficulty with most of them is that they are arranged only for the use of semi-solid paraffin expressed by the screw method, or for the liquefied hot paraffin in a continuous flow. The author's syringe (Fig. 330) is so constructed that it may be adapted for either variety of paraffin. For the main ideas in the construction of this instrument, the author is indebted to V. Mueller, instrument maker, Chicago.

The great advantage which the instrument of Broeckaert has over

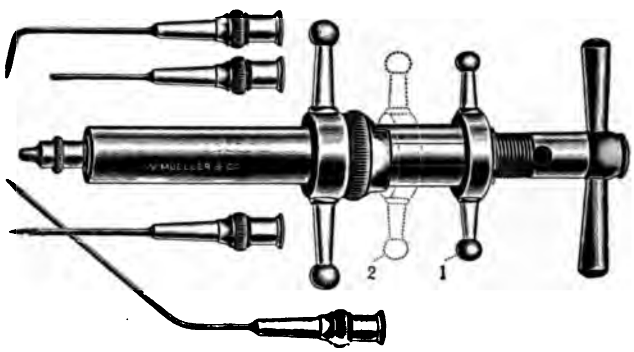


Fig. 330.
Beck's paraffin syringe.

others is that it can be managed by the operator with one hand while the other can be used to prevent the paraffin from escaping into the loose tissues. Moreover, when one is injecting intranasally the other hand is free to dilate the nostril.

Various shaped needles will suggest themselves for use in different special localities. In injections about the nose a needle with too large a caliber should be avoided, since the opening will prevent healing; in fact, there is greater liability to infection. Again, the bleeding is greater from the skin, although it is never of any great consequence

Material.—Paraffin which has a melting point of 110° F., with the following formula: sterile plate paraffin, 15, sterile white vaselin, 120, is made up and filled into glass tubes, open at both ends and having an inner diameter exactly equal to that of the tube in the syringe (0.5 cm.). The ends are corked, and the cork-stopper is coated with a layer

of paraffin. These tubes are always ready for refilling the syringe, and all that is necessary is to wash them in bichlorid and alcohol before using.

Filling the Syringe (while the needle is attached).—Turn the ring bar so that it can be slipped down, thus releasing the piston screw. Pull out the handle of the syringe, so that the paraffin chamber is opened. Then uncorking both ends of a prepared tube and holding one end right over the paraffin chamber of the syringe, the paraffin is pushed into it by means of the metal rod. It should be noted that the end where the needle is to be attached is to be free from paraffin; otherwise the air thus included will prevent the paraffin from filling the entire chamber of the syringe, and on injecting, some air will enter the tissues. This may not do any harm, but may elevate the tissues and deceive the operator as to the amount of paraffin injected.

If hot liquid paraffin is to be employed, then the ring bar is left down and the paraffin is drawn up through the needle. Instead of this procedure, the syringe may be filled first and the needle attached afterwards. The syringe should be kept in very warm water until ready to be used. It may, however, become too hot and uncomfortable to hold, and for this reason the author employs heavy rubber gloves when using this method.

Preparation of Field.—Until two years ago, thorough scrubbing with soap and water, bichlorid, ether and alcohol, was the usual routine before injections, but since then the author simply has the field scrubbed with alcohol, following which he applies the ten per cent alcoholic solution of tincture of iodin.

PARAFFIN INJECTIONS IN NASAL DEFICIENCIES.—The skin must be sufficiently loose to enable one to raise it. If through contraction of scar tissue or otherwise this is not possible, a small incision must first be made and the skin dissected loose. If the resulting incision is too large and there is danger of the paraffin exuding, it is well to put in a stitch.

Injection.—Raise the skin as in any subcutaneous injection over the site to be injected, and thrust the needle, apart from the syringe, through the skin. The direction of the needle is from the root of the nose downward. As a rule no blood comes back through the needle, but if this should occur, draw the needle slightly outward and pass in a somewhat different direction. In order to prevent the cavity filling with blood and forming a hematoma, it is best to compress the parts for a few moments, before injecting the paraffin. Now attach the syringe by holding the needle steady, and then turn the handle while holding the barrel of the syringe by the crossbars. An assistant holds his fingers firmly over the root and side of the nose so as to prevent

the paraffin from finding its way into the loose tissue or other places where no paraffin is desired. If cold paraffin is employed this is not very likely to happen. It is well repeatedly to draw the needle outward almost to the skin opening while injecting, in order to liberate it from the mass, and in that way the paraffin will be more uniformly distributed. Again, a certain amount of molding is possible while injecting, and this may be aided by irrigating the skin with very warm water or hot compresses. After having given a proper shape to the injected mass, ice applications will facilitate its solidification and the retention of its shape. The greatest care must be exercised, as already pointed out, not to inject too much at one time; it is better to repeat the injection a number of times.

Paraffin Injections in Ear Deficiencies.—The most frequent indication is the absorption of cartilage by pressure, the result of a perichondritis or a hematoma, and this affords the best results although the defect may be very large. The paraffin mass, however, will never hold up the ear as cartilage did. The preparations are the same as in nasal injections. The liquid hot paraffin gives better results than the cold, since it gives greater consistency to the ear.

After the two layers of the skin of the deformed ear are thoroughly separated by dissection, the paraffin is filled into the cavity as into a bag and allowed to solidify somewhat. Supports or splints made by taking two impressions of the other ear with dental compound (front and back) are employed. Then the ear is roughly shaped and the excess of paraffin is allowed to escape through the small incision that was made. Then apply a thin layer of cotton, the dental compound splints, strap with adhesive plaster, and bandage to the side of the head. This is left undisturbed for one week unless there should be much pain or fever. Subsequently a cotton support and bandage are worn for about three weeks, until organization has taken place. In the subsequent treatment of a newly-made ear by plastic, an injection of paraffin between the skin layers may undoubtedly be beneficial to the consistency and appearance of the ear.

Paraffin Injections in Collapsed Alæ.

Menzel's Method.—

1. Pack the nose (vestibule) firmly with cotton.

2. Pass the needle under the skin overlying the cartilage at the crease between the nose and cheek, forward and upward.

3. Distribute the injected mass (equal parts of paraffin and vaselin) over the ala so as to stiffen it, but not to any great degree, so that when the cotton is removed from the nose the inner surface will not

approach the septum. Cotton packing is permitted to remain for twenty-four hours.

VIII. Reduction Method.

In order to diminish as a whole or in part the size of a nose enlarged by some pathologic condition, traumatism, or deformity of unknown origin, extranasal, intranasal or combined methods may be employed. Thus it is that resection of a portion of the nasal septum by the in-

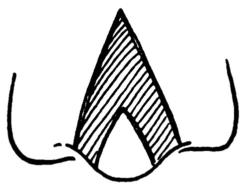


Fig. 331.

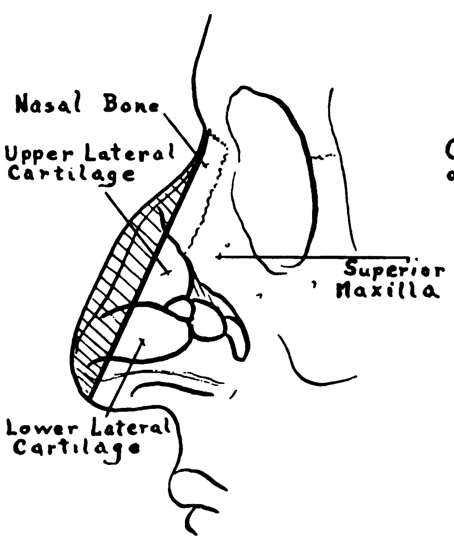


Fig. 332.

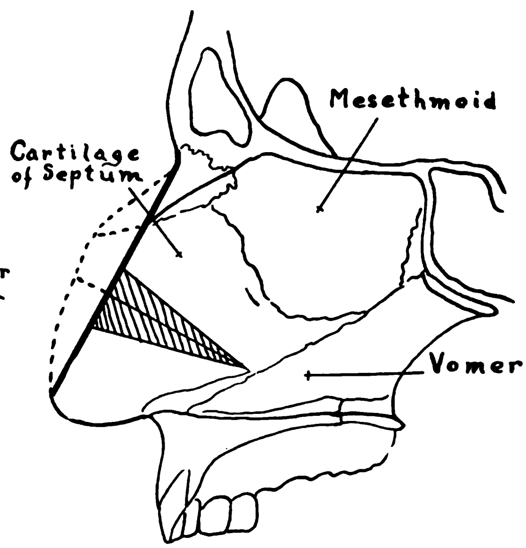


Fig. 333.

Joseph's operation for reducing hump, length, width of nose and large nostrils.

tranasal method will influence the shape of the nose, but alone will seldom straighten it. By intranasal methods, that is through incision within the alæ, redundances may be removed or displaced so as to fill out deficiencies in the nose. A very large nose, affected with chronic rosaceous hypertrophy, requires operation by external methods. Also many very large hump and twisted noses are best attacked by external methods. The minor deformities, as large alæ or large nostrils or a very

Fig. 334.

Fig. 335.

Kolle's operation for hump nose.

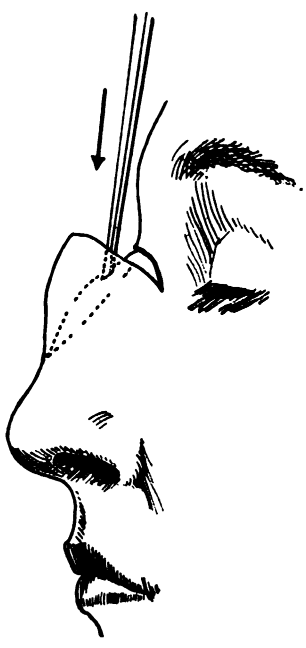


Fig. 336.

Fig. 337.

Beck's operation for hump nose.

long hanging tip of the nose, are as a rule best corrected by external methods.

Joseph's Operation for Reducing Hump, Length, Width of Nose and Large Nostrils.

1. An A-shaped incision is made over the anterolateral portion of the nose, just above the tip. A corresponding incision is made above this, the distance depending on the amount of tissue that is to be removed. The ends of these incisions should reach to the margins of the alæ. (Fig. 331.)
2. A wedge-shaped portion of the nose is now taken out, including the skin between the two incisions, the underlying connective tissue and cartilage. The hump or crest of the nose, containing bones and cartilage, is shaved off by means of the chisel and the knife. (Fig. 332.)
3. The nose is shortened by excising a wedge-shaped portion of the cartilaginous septum, with its base at the dorsum of the nose and the apex running backward as far as the bony portion of the septum. (Fig. 333.)
4. Suturing the parts together, one deep suture should pass between the upper and lower margin of the excised septum at the crest, so as to bring the point well up. The other sutures are superficial ones.
5. The dressing should be such as to hold the tip of the nose upward.

Kolle's Operation for Hump Nose.

1. Make a longitudinal incision over the prominence of the hump (Fig. 334) and dissect off the skin and periosteum to either side of it until it is completely exposed. (Fig. 335.)
2. By the aid of a chisel the hump is taken off, care being taken not to enter the interior of the nose or to tear away the mucous membrane. If there is a tear it should be sutured at once.
3. If a broad bone defect is obtained by the removal of the hump, then by the aid of a heavy forceps the margins may be pressed together to obtain a sharper ridge.
4. Close defect by Halsted's subcuticular periosteal suture.

Beck's Operation.

1. Instead of the longitudinal incision, a transverse one curved upward, subsequently to be hidden by spectacles, is made across the bridge of the nose. The ends of this incision may go to some distance on the side of the nose and thus create a flap which will easily expose the hump. (Fig. 336.)

2. By means of a chisel take off the hump. (Fig. 337.)

3. Close in the same manner as in the preceding operation.

Ballenger's Operation for Hump Nose (Intranasal).

1. By means of scalpel feel the lower border of the nasal bones and pass through mucous membrane between the skin and nasal bones.

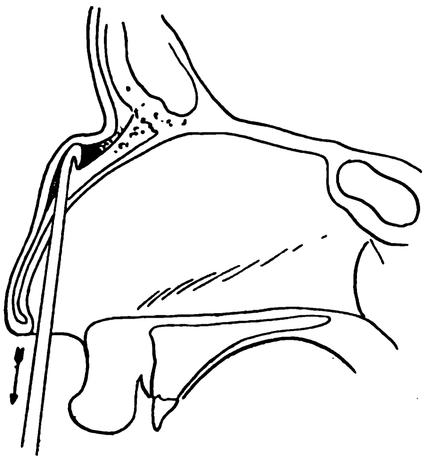


Fig. 338.
Ballenger's operation for hump nose.

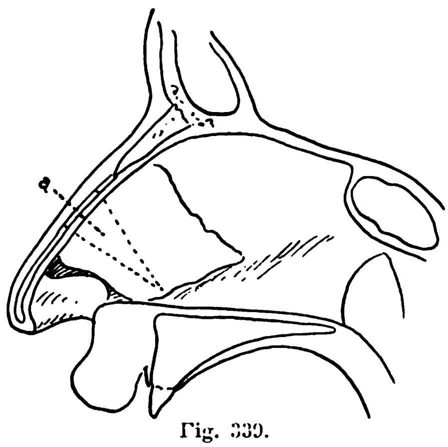


Fig. 339.
Ballenger's operation for long nose.

2. Elevate the skin from the underlying anterior portion of the nasal bones by the aid of a Freer type elevator.

3. Introduce the Ballenger reverse chisel and with a downward and forward pull, parallel to the bridge of the nose, shave off the hump. (Fig. 338.)

Ballenger's Operation for Long Nose.

1. Make two incisions through mucous membrane and cartilage to the opposite mucoperichondrium above the point of the nose close

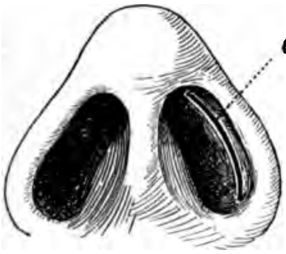


Fig. 340.

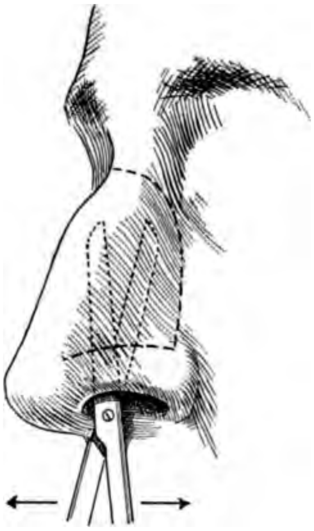


Fig. 341.

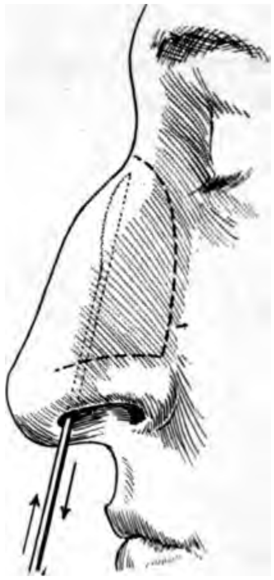


Fig. 342.

Fig. 343

Fig. 344.

Roe's operation for hump, twist and broad ala or large nostrils. (Illustrated by Beck.)

to the dorsum and carry downward and backward to meet at the floor of the nose. Dissect the mucoperichondrium free. (Fig. 339.)

2. At the dorsum of the nose the base of this cartilage flap is severed and the wedge-shaped piece removed.

3. The nose is elevated by a sort of sling bandage of adhesive plaster, and held thus for from four to eight days.

Roe's Operation for Hump, Twist and Broad Ala or Large Nostrils.

1. Make an incision at the junction of the inner alar skin surface with the nasal mucous membrane, and pass below the skin over the cartilage and nasal bones. (Fig. 340.)

2. Elevate the skin and subcutaneous connective tissue by means of elevators (the author prefers Mayo scissors, as by opening the blades the tissues are separated with the least traumatism) until the entire hump is exposed. (Fig. 341.)

3. By means of a small saw the hump made up of cartilage and bone is sawed off (Fig. 342) and removed. If, as is frequently the case, the hump nose is at the same time twisted and depressed, the hump is sawed off partially, but is left attached above to the fibrous tissue as a sort of a pedicle and slid over into the depression. Here it is subsequently retained. (Figs. 343 and 344.) This fibrous pedicle is not absolutely necessary, as the bone and cartilage chip will live any way. If the depression be greater than the bone cartilage chip can fill out, small subcutaneous tissue flaps are turned back into the depression. These are as a rule taken from the tip of lateral portions of the alæ, which also are large in many cases.

4. Either a soft metal or adhesive retention dressing is applied over the nose and the incision within the ala is sutured.

Roe's Operation for Broad Alæ and Large Nostrils. (Fig. 345.)

1. An incision is made within the nostrils closer to the exterior than in the preceding operation.

2. The cartilage is liberated and part of it is excised together with some of the subcutaneous tissue. (Fig. 346.)

3. Suture and insert two small rubber tubes. Fig. 347 shows final results.

Beck's Operation for Hump Nose.

1. Lift up tip of the nose and make with a knife a small semicircular incision in the anterolateral portion of the vestibule at the mucocutaneous junction of the cartilage and bone.

Fig. 345.

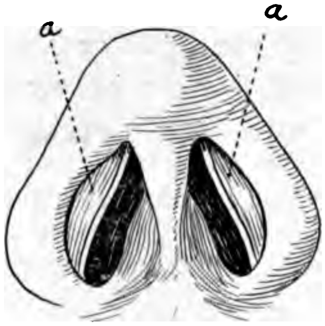


Fig. 346.

Fig. 347.

Roe's operation for broad alæ or large nostrils. (Illustrated by Beck.)

2. Dissect over the hump with Mayo's scissors as in Fig. 348. With the same scissors engage and sever the hump which is usually made up of cartilage.

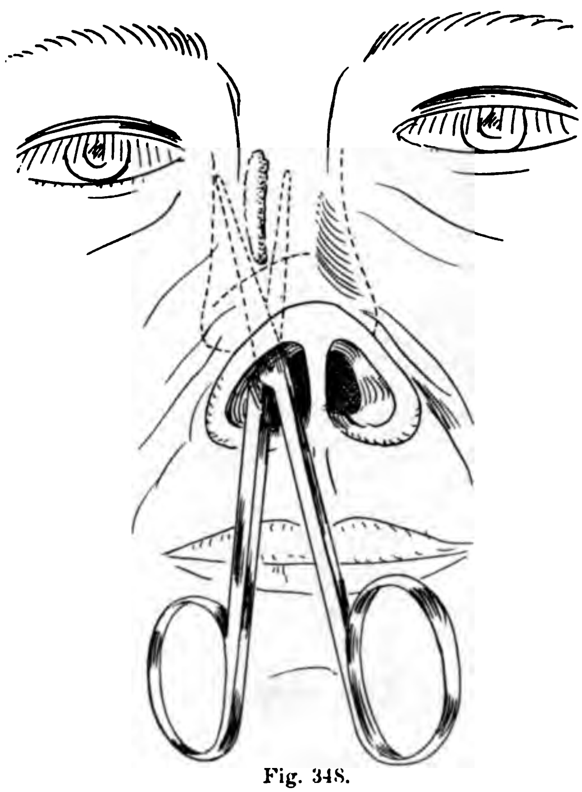


Fig. 348.

Beck's operation for hump nose.

3. Displace this fragment by external manipulation and by the aid of fine forceps or the scissors in the eventually existing depression (if none exist remove the piece).

4. If the base from which the hump is removed, is very broad and sharp, the edges may be filed off with a straight rasp or shaved off with a chisel.

5. The blood expressed from the cavity is mopped away and an

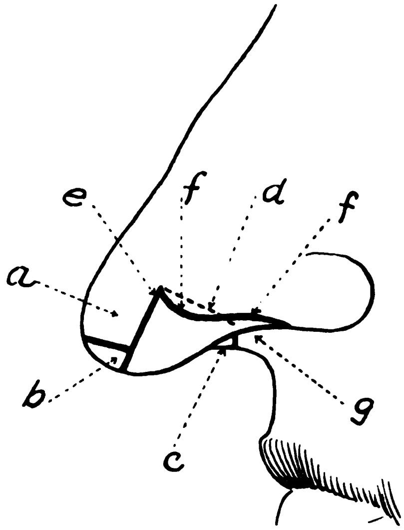


Fig. 349.

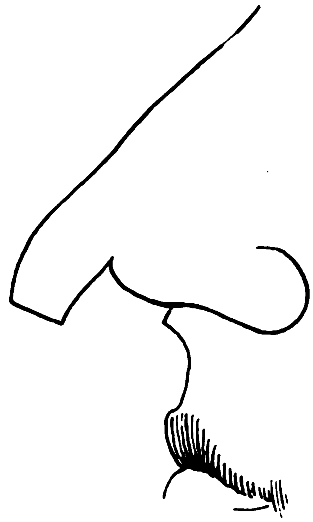


Fig. 350.

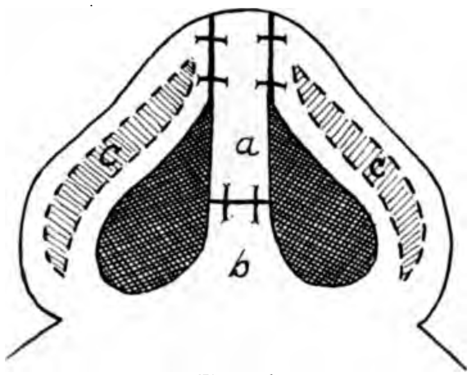


Fig. 351.

Kolle's operation for long tip nose.

adhesive plaster is drawn tightly over the bridge of the nose with no dressing between it and the skin.

6. One silk stitch is used to close the wound.

Kolle's Operation for Long Tip Nose.

1. Make an incision on either side through the entire thickness of the nose, including the septum, as shown in Fig. 349, beginning at *e*, downward.

2. From *e* to *g*, in a natural curve line, all the tissues of the alæ are severed.

3. A short upward cut is made through the entire thickness of the columella at *c*, from which point the septum is cut as shown in the dotted line *d*, towards *e*.

4. The tip *b* of the part *a* is now cut off, leaving the nose as in Fig. 350.

5. The front part *a* is now sutured to the remaining portions of the columella at *b*, and the cartilages of the alæ where they are protruding are excised to such an extent as to permit union of the skin over them, as shown in Fig. 351.

IX. Prothetic or Artificial Noses.

There are frequently anatomic, pathologic and social conditions that require the correction of the nasal deformity to be made by the aid of artificial devices. It can be said without question that so far as the appearance is concerned, at least if not too closely scrutinized, an artificial nose that is correctly made looks much better than one that results from the most of the best surgical procedures. (Figs. 352-355.)

For instance, in cases of carcinoma which have been operated upon to the extent of removing the greater part of the nose, there will naturally be some hesitation about performing a plastic operation. In cases where the face is all scarred up it is much better to employ an artificial nose. There are some people who have not the necessary time to have plastic work done on their noses by reason of the necessity of making a living and providing for their families.

These artificial noses may be made to fit any kind of defect and are usually held in place by spectacles and adhesive (actors') paste. The making of these noses is left to a specialist in this line, but only under the direction of a physician, since the condition of the nose must be thoroughly examined before fitting an artificial nose.

Artificial Supports.—In noses in which the bony framework is destroyed or absent one may introduce wire or rubber supports made especially for each individual case. In cases of lues, in which there exists a perforation in the hard palate, a sort of a horn may be vulcanized upon a dental plate that will push the collapsed nose forward and thus support it.

X. Orthopedic Method.

By wearing certain forms of apparatus which usually must be specially made in each individual case, a deformity may be changed, especially in early life or when it follows a traumatism. It is also pos-

Fig. 352.

Fig. 353.

Fig. 354.

Fig. 355.

Prothetic or artificial noses.

sible to correct collapsed or saddle-back nose by special methods. (Fig. 324.)

XI.—Operations for Closing Perforating Septum.

Goldstein's Operation.

1. Freshen up the edges of the perforation and elevate the mucoperichondrium from the cartilage for about one-half inch.
2. Remove a small rim of the cartilage all along the perforation by means of Ballenger's single-tined swivel knife. (Fig. 356.)
3. Outline a mucoperichondrial flap on the most convenient por-

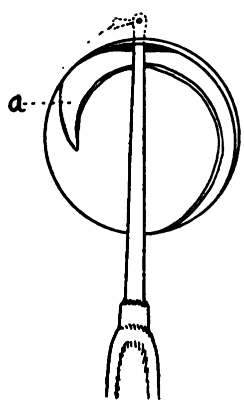


Fig. 356.

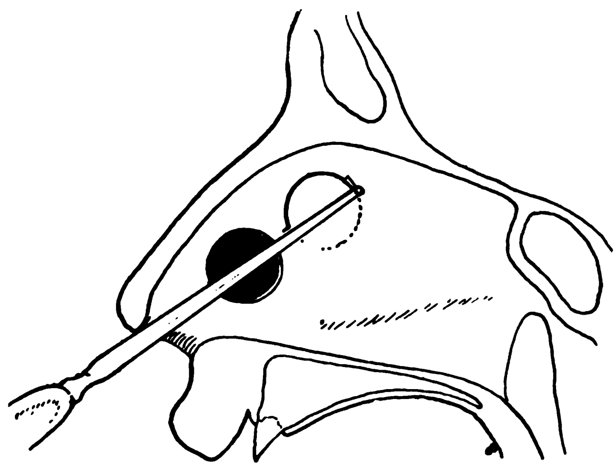


Fig. 357.

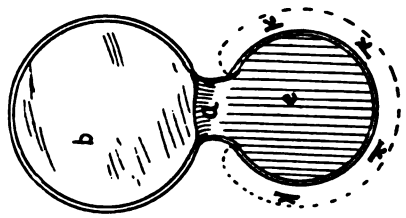


Fig. 358.
Goldstein's operation for perforation of septum.

tion of the septum, with the hinge pedicle at the margin of the perforation. The author would suggest the use of the cautery in order to destroy the epithelium so that the flap may heal more easily. (Fig. 357.)

4. Dissect this flap and bring it between the two layers of the mucoperichondrium about the perforation.
5. Suture through and through by a quilted suture with the aid of Yankauer needle. (Fig. 358.)

Hazeltine's Operation for Perforation of Septum.

1. Freshen up the margins *c-c* (Fig. 359) and elevate the mucoperichondrium (as in the submucous resection) where the anterior flap lies.

2. An incision through the mucoperichondrium about one-half

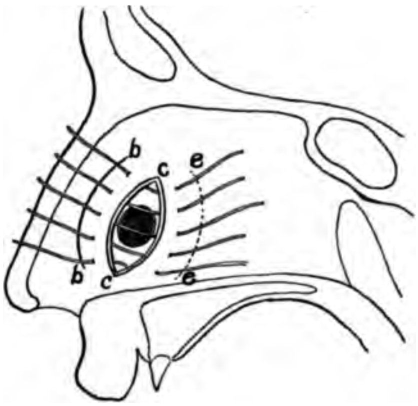


Fig. 359.

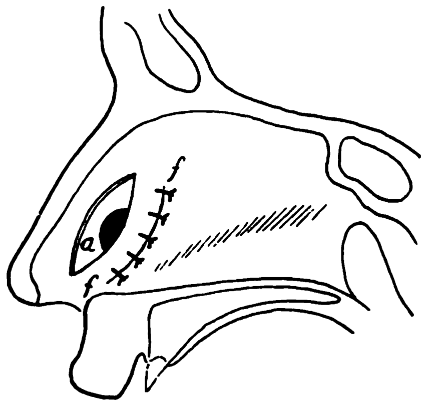


Fig. 360.

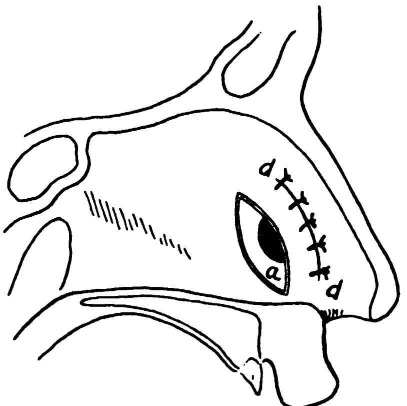


Fig. 361.
Hazeltine's operation for perforation of septum.

to one inch anteriorly to perforation (*b-b*, Fig. 359) is made, and the flap, with pedicle above and below, is dissected as far as the perforation.

3. If the anterior flap was made on the right side, then make the posterior flap (*e-e*, Fig. 359) on the left side, by a similar incision through the mucoperichondrium about one-half to one inch back of perforation.

4. Approximate and suture anterior flap to posterior margin of perforation (*f-f*, Fig. 360) and slide the posterior flap of the opposite side forward and suture to the anterior margins of perforation (*d-d*, Fig. 361). Denuded areas (*a-a*) from the flap heal by granulation.

Goldsmith's Operation for Closure of Septal Perforations.

1. Excise margin of perforation by the Ballenger's single-tine swivel knife.
2. Separate the mucoperichondrial flap on either side all around the perforation.
3. Take a piece of cartilage either from another case just operated upon for deviation by the submucous method, or a piece of sheep's septal cartilage, which must be larger than the perforation.
4. Slip this cartilage plate into the dissected flaps and replace carefully all around the perforation.
5. Put in anterior nasal splints to retain the cartilage and mucoperichondrium in place for forty-eight hours.
6. Subsequent cauterization to assist in epithelialization and application of scarlet red ointment constitute the after-treatment.

OTOPLASTY.

Otoplasty is a subject that has received very little attention as compared with rhinoplasty, and most text-books contain very meager information on the subject. However, much better cosmetic results are obtained than in nasal plastics, especially in deformities or malpositions. In the absence of the entire or a greater portion of the auricle, the results except with prothesis are very unsatisfactory. There is one comforting fact that in women deformities of the ear may be hidden by long hair. Ear plastics are performed principally for cosmetic reasons, since the physiologic function is but slightly influenced unless it be in cases of congenital atresia, with presence of a good middle ear and auditory nerve apparatus.

Classifications According to Kolle.

I. Preauricular deficiency $\begin{cases} \text{Unilateral.} \\ \text{Bilateral.} \end{cases}$

II. Postauricular deficiency. $\begin{cases} \text{Unilateral.} \\ \text{Bilateral.} \end{cases}$

General Classification.

I. Macrotia (large ear).
II. Asymmetry of the two ears.
III. Heterotopy (false position of the auricle).
IV. Synechia of the posterior surface of the auricle.
V. Projecting, roll or dog ears.
VI. Pointed ear (Darwinian tubercle).
VII. Macacus ear.
VIII. Wildermuth's ear.
IX. Absence of helix.
X. Lobule deformities and abnormalities.
XI. Synechia of lobule.
XII. Shriveled ear following perichondritis or infected hematoma or abscess.
XIII. Traumatic destruction, complete or partial.
XIV. Poliotia.
XV. Microtia.

Usual Operation for Macrotia.

1. Excise a V-shaped segment of the auricle, including all the structures at the upper and larger part. The base of the V is at the

Fig. 362.

Fig. 363.

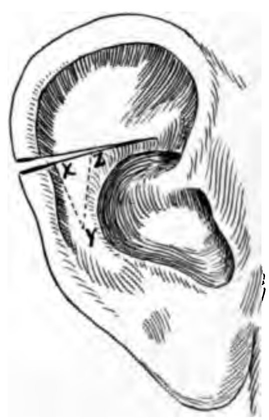


Fig. 364.

Usual operation for macrotia.

external border of the ear. (Figs. 362 and 363.) The size of the wedge-shaped piece to be removed will depend on the size of the deformity to be corrected.

2. Excise a narrow wedge-shaped segment from the lower half of the auricle, the base of this wedge being at the incision, the apex directed towards the lobule. (Fig. 364.) This is necessary to make the upper and lower portions of the auricle fit for exact approximation of the helix.

3. Suture the lower wedge first and then the large transverse defect after exact approximation.

Fig. 365.

Fig. 366.

Parkhill's operation for macrotia.

Parkhill's Operation for Macrotia.

1. Make an incision through all the structures in line with the curve of the antihelix.

2. From each extremity of this incision make a curvilinear incision towards the outer margins.

3. A small tongue-shaped flap is further excised from this last incision towards the external border, in order to shorten the long diameter of the ear, and the crescentic excision will make the width of the ear smaller. This will make a crescent-shaped defect with a little tongue. (Fig. 365.) Suture defect. (Fig. 366.)

Cheyne and Burghard's Operation for Macrotia.

1. Excise a V-shaped piece of the auricle from the upper and outer part, the acute angle of the V being carried almost into the concha. (Fig. 367.)

2. Corresponding to the upper border of the concha a semilunar incision is made through all the structures.

3. From the latter's extreme ends two short curved incisions are made to meet the V-shaped incision, removing the two pieces thus formed. (Fig. 367.)

4. The parts are brought together and sutured on both sides of the auricle. (Fig. 368.)

Goldstein's Operation for Macrotia.

1. Make a curvilinear incision down to the cartilage, with its convexity directed to the outer margin of the ear, on the posterior surface of the auricle. (Fig. 369.)

Fig. 367.

Fig. 368.

Cheyne and Burghard's operation for macrotia.

2. Dissect off this flap and lay over the mastoid region. (Fig. 370.)

3. Cut through the cartilage in the perpendicular direction of the ear and curve the incision at each extremity for a short distance in order to make a sort of a cartilage flap. Great care must be exercised not to cut through the skin on the anterior surface of auricle, in other words, not to buttonhole it. (Fig. 370.)

4. With a dissector, as employed in a submucous resection of the septum, the dermoperichondrium is dissected off from the cartilage, thus making the cartilage flap, and the dissection is continued a little beyond the necessary limits so as to enable one to slide the flap over with greater ease.

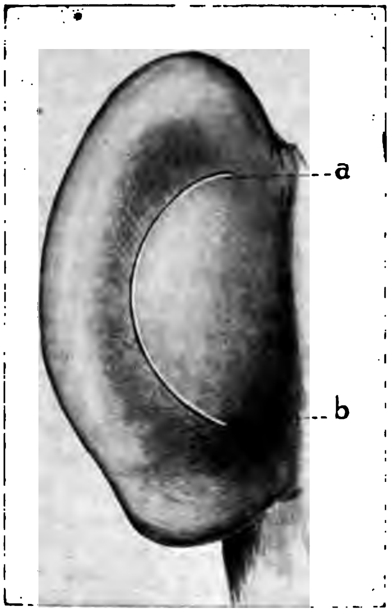


Fig. 369.

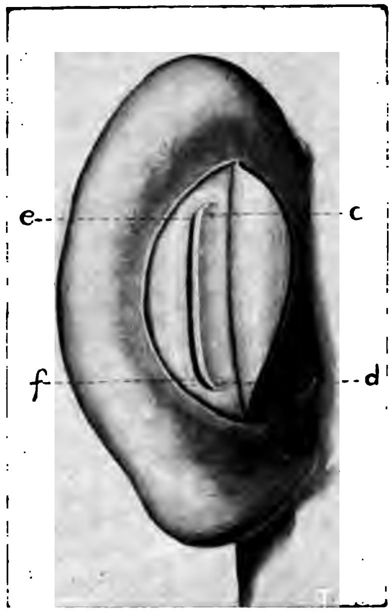


Fig. 370.

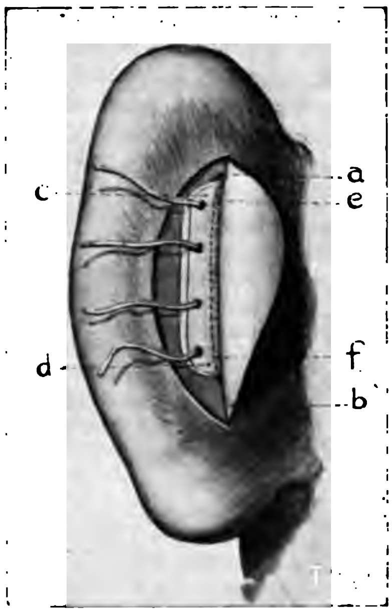


Fig. 371.

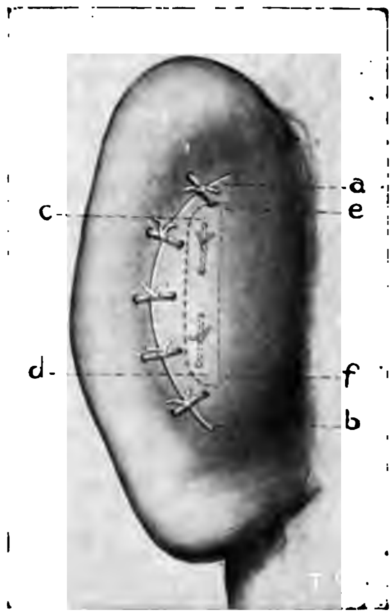


Fig. 372.

Goldstein's operation for macrotia.

5. Dissect also the dermoperichondrium anteriorly from the external portion of the exposed cartilage because the subsequent suturing will have to be done at that point.

6. Pass a small sharp curved needle armed with fine chromicized catgut through the upper part of the internal cartilage flap (which will become the overriding one). Then at the same place pass the needle through the external cartilage flap, which will become the overridden one, and taking in a small bit of cartilage come out through both flaps, completing one mattress suture. Another suture of the same type is made in the lower portion of the incision, and the parts are ready for suture. (Fig. 371.)

7. While the assistant holds the parts together so as to get an overriding of the internal flap, the sutures are tied.

8. The posterior dermoperichondrium flap is brought back again and sutured. (Fig. 372.)

Goldstein's Operation for Projecting Ear.

1. Make two curvilinear incisions back of the auricle, one having its convex border towards the outer border of the ear, the other towards the occiput, thus creating an elliptical flap of skin. (Fig. 373.)

2. Dissect off this skin flap, exposing the perichondrium of the auricle and the periosteum of the mastoid. (Fig. 373.)

3. Excise an elliptical portion of the cartilage of a size depending upon the amount of projection present. (Fig. 374.)

4. Draw the cartilage towards the mastoid region and suture to the periosteum at this point. (Fig. 375.)

5. Close the skin defect by a few interrupted sutures. (Fig. 376.)

Beck's Operation for Roll Ear or So-called Dog-ear. (Fig. 377.)

1. Make an incision through the skin on the posterior part of the auricle in line with the usual site of the antihelix.

2. Dissect the skin freely on either side of the incision, but not the perichondrium.

3. Excise a very thin sliver of cartilage the whole length of the skin incision in a curvilinear shape. (Fig. 378.)

4. Bend back the helix and form an antihelix by doubling the cartilage upon itself. Hold the parts together on the anterior surface of the ear.

5. Pass two mattress sutures of silkworm gut through the skin, perichondrium, cartilage, two layers of perichondrium, cartilage, perichondrium and skin. These are tied over pieces of rubber tissue in order not to cut into the skin. (Fig. 379.)

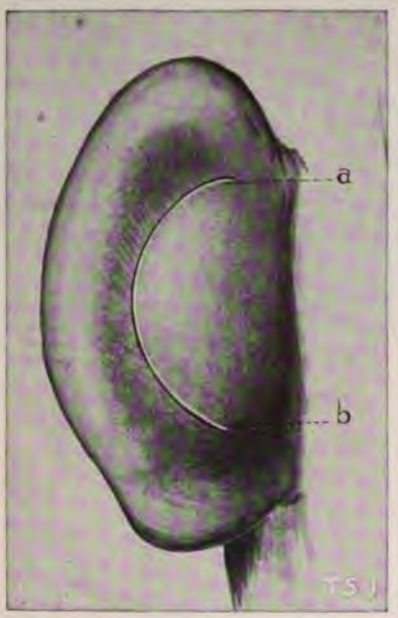


Fig. 369.

Fig. 370.

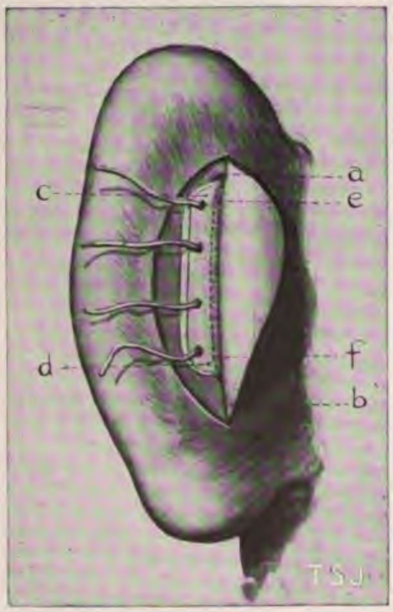


Fig. 371.

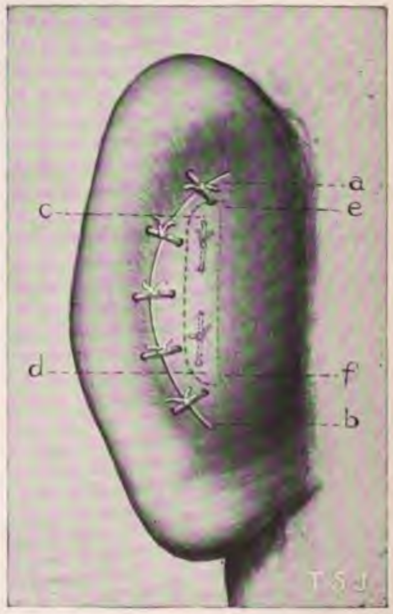


Fig. 372.

Goldstein's operation for macrotia.

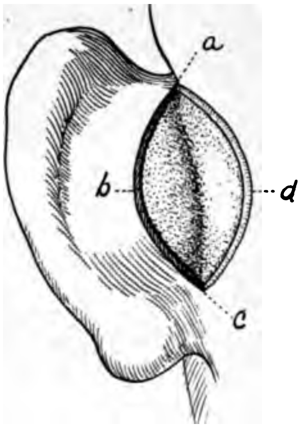


Fig. 373.

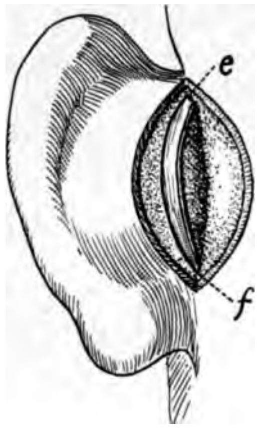


Fig. 374.

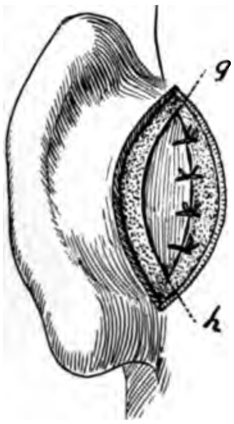


Fig. 375.

Fig. 376.

Goldstein's operation for projecting ear.

Fig. 377.

Fig. 378.

Fig. 379.

Beck's operation for roll ear or so-called dog-ear.

6. Excise small portions of excess skin on the posterior surface and make a subcuticular suture.

This same operation can be adopted for the formation of an antihelix in an ear that is not rolled.

Szymanowski's Operation for Reconstructing an Auricle.

1. Make an incision as outlined in Fig. 380, back of the rudimentary ear or external auditory meatus, about the size of the pinna on the opposite side, taking in the skin and all subcutaneous tissue possible.
2. Dissect the above outlined flap and fold at the constricted middle part so as to bring the raw surfaces in apposition.
3. Suture along the margins above and below.
4. Cover the denuded area of defect by skin grafts or slide a flap from the occipital region and support posteriorly by gauze pads.

Subsequent Correction.

5. Incise above and below as shown in Fig. 381, placing small triangular flaps, back of the auricle and bringing the latter forward into a more projecting shape. Also excise a small portion of the newly-formed auricle from the lower margin, to shape a lobule.

Beck's Operation for Synechia of Auricle to the Mastoid Squama.

1. Sever the adherent ear from the mastoid surface and place between the surfaces gauze or rubber tissue to prevent reunion and wait for granulation formation.
2. Make a correctly outlined flap to cover the mastoid region as well as posterior surface of auricle, on the forearm, on the side opposite to the synechia, since the subsequent immobilization is more com fortable in that way. Place rubber tissue below this flap to prevent its reuniting and allow it to become thicker.

One Week Later.

3. Freshen up the surfaces on the mastoid region, turn the auricle forward and suture into the forearm flap on the greater portion of the defect. (Fig. 382.)
4. Apply regular plaster retention cast as in the Italian plastic operation for the nose.

Ten Days Later.

5. Sever pedicle from forearm and suture on all sides, special care being taken to make a natural fold at the insertion of the auricle. This is best accomplished by a spring wire like a spectacle frame over

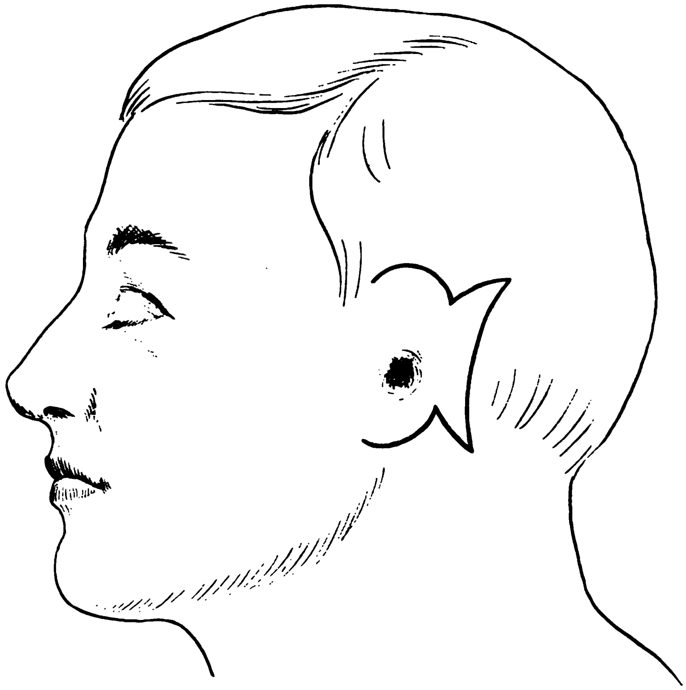


Fig. 380.

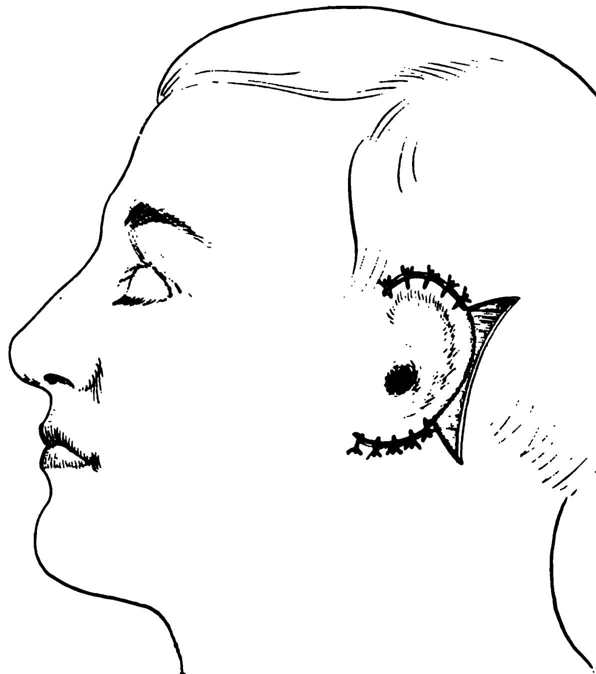


Fig. 381.

Szymanowski's operation for reconstructing an auricle.

some light dressing, to be held by the wearing of spectacles for the time being.

6. Suture defect in forearm.

Instead of using the flap from the forearm one or two Wolfe grafts, or Thiersch grafting, may be employed to cover the defect. Again, the sliding over of a flap from the lateral portion of the occiput, even

Fig. 382.
Beck's operation for synechia of auricle to mastoid.

though it contain hair, to cover the mastoid region, will aid a great deal and prevent the further formation of a synechia on the posterior surface of the auricle. The latter may be covered by skin grafts.

Roberts' Operation for Absence of Ear.

This author's procedure is very much like the operation illustrated in Figs. 383-386, except that he employs only skin and subcutaneous tissue.

Simple Operation for Colobomata.

Excise the scar margins so as to obtain fresh dermal layers and suture anteriorly as well as posteriorly with special care at the tip of the lobule, since keloid is liable to form. (Figs. 387 and 388.)

Green's Operation for Colobomata.

1. Remove the cicatrized skin from the notch without cutting it away at the tip limits, but pull it down. (Fig. 389.)

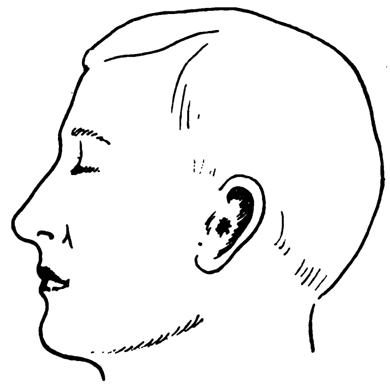


Fig. 383.

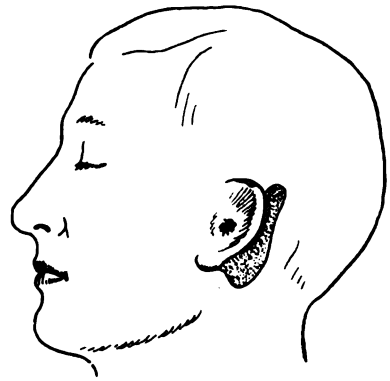


Fig. 384.

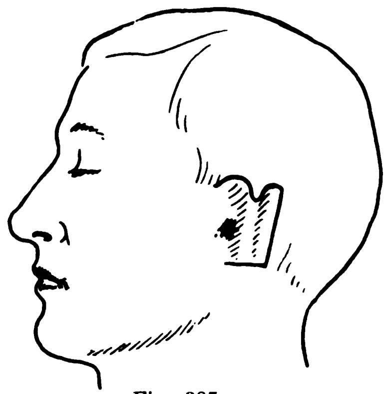


Fig. 385.

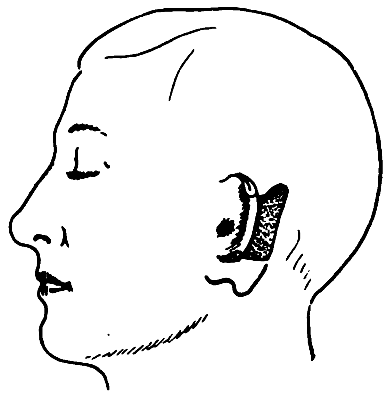


Fig. 386.

Robert's operation for absence of ear.

2. Bring the denuded surfaces together and employ the little ribbon of skin to make a rounded margin of the tip. (Fig. 390.)

Monk's Operation for Prominent Ear.

1. Excise a strip of skin and subcutaneous tissue in the form illustrated in Fig. 391, making the one incision all along the attachment of the auricle and the other corresponding to the degree of projection.

The flap is made either broad on the top, middle or bottom, depending on the location of the prominence.

2. Stitches are carefully applied so as to pucker the defect thoroughly, and perfect approximation is imperative.

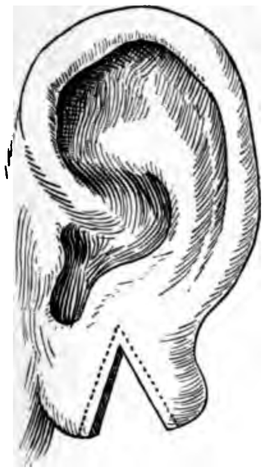


Fig. 387.

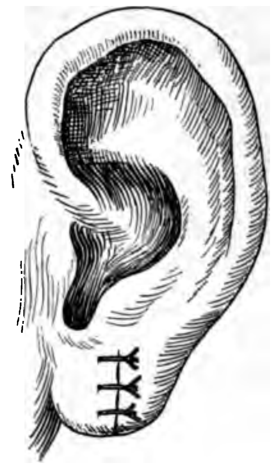


Fig. 388.

Simple operation for colobomata.

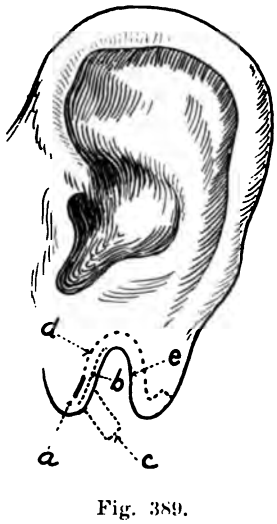


Fig. 389.

Fig. 390.

Green's operation for colobomata.

Kolle's Operation for Projecting Ear.

1. Make an incision on the back of the auricle three-quarters of an inch from its outer margin, beginning above at the sulcus and curving upward and outward and then gradually downward until the lower part of the sulcus is reached. The skin only is incised.

2. Bleeding at once takes place and by turning the auricle over the mastoid and side of head, an outline in blood is made which corresponds to the incision to be made.

3. This second incision when completed will outline a heart-shaped flap, which is removed. (Fig. 392.)

4. An elliptical piece of cartilage is removed in extremely projecting ears without going through the anterior skin. (Fig. 393.)

5. Suture the cartilage with catgut separately and then apply continuous sutures from above downward to the skin margins to close the defect and to bring the ear close to the side of the head.

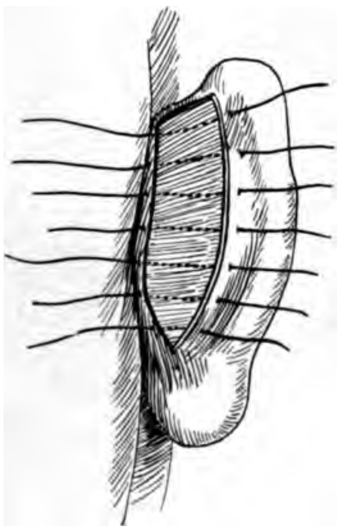


Fig. 391.

Monk's operation for prominent ear.

Fig. 392.

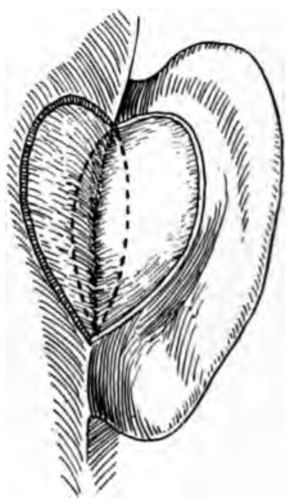


Fig. 393.

Kolle's operation for projecting ear.

6. Place a pad over ear and use a bandage that is not too firm.

7. Allow stitches to remain for nine days and do not disturb the wound.

Postauricular Deficiencies or Retroauricular Fistulæ.

These are as a rule the result of mastoid operations (radical) which formerly were performed by leaving a large retroauricular drainage for a long time; when healing took place, the cavity was lined by epithelium continuous with the outside skin. Some of the cases, even when the posterior bony canal was taken away and the membranous canal was split in the usual plastic manner, remained open in the back of the ear and then there was a cavity which was

lined by epidermis continuous with the skin of the external auditory canal and the skin on the posterior surface of the auricle.

Trautmann's Operation for Closure of the Posterior Deficiencies.

1. Incise the fistula, making two crescentic flaps with their epidermal layer looking towards the auditory canal. (Fig. 394.) (This is done only in those cases in which the usual plastic of external auditory meatus in connection with the radical mastoid operation has been performed.)
2. Stitch these two flaps with catgut. (Fig. 395.)
3. Dissect freely the skin and perichondrium over the pinna and also the skin and periosteum over mastoid region. (Fig. 396.)
4. Unite these by interrupted sutures over the two lower flaps. (Fig. 397.)

Von Mosetig-Moorhoff Operation.

1. Make a tongue-shaped flap below the fistulous opening, leaving the hinged pedicle at the lower margin. (Fig. 398.)
2. Dissect loose, but not too close to the margin of the opening or else too little blood supply will remain to nourish the flap. (Fig. 399.)
3. Freshen up the margin of the fistula and loosen the margin thoroughly for suture.
4. Turn the flap with its dermal layer towards the inside (towards the auditory canal) and suture to margin of fistula. (Fig. 400.)
5. Close newly-formed defect by first loosening its margin (Fig. 401), subsequently either cover the turned-in flap with skin graft or allow it to granulate and cicatrize. It becomes necessary at times to make secondary corrections at the pedicle portion.

Goldstein's Operation.

1. Loosen the margins about the fistula freely on the cartilage as well as on the mastoid side, and freshen up the margins.
2. Make lateral incisions to allow free coaptation of the margins of the fistula. (Fig. 402.)
3. Close by means of Michel's clips. (Fig. 403.)
4. Allow the defects created by counter incisions for relaxation to granulate.

Ear Prothesis.

As in nasal deformities, there are times when the local as well as the general condition does not warrant an operation of magnitude; under such circumstances much better results are obtained by the use of a well-fitting artificial ear.

Fig. 394.

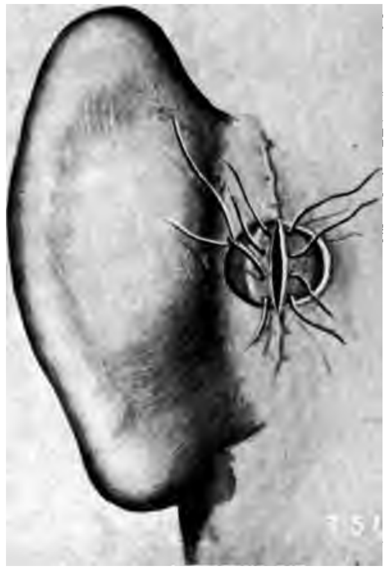


Fig. 395.

Fig. 396.

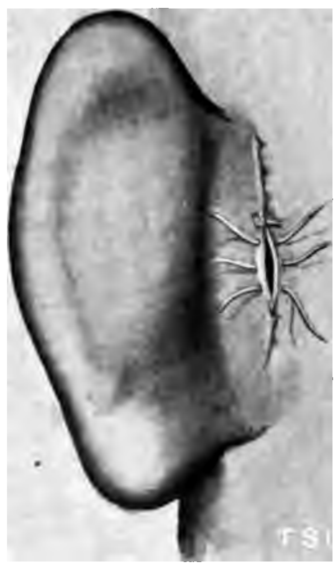


Fig. 397.

The Trautmann operation for closure of posterior deficiencies.

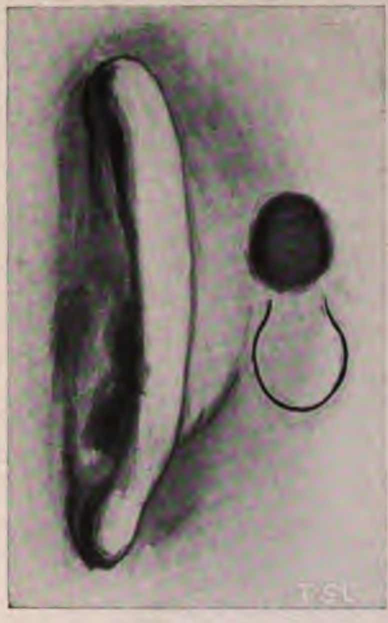


Fig. 398.

Fig. 399.

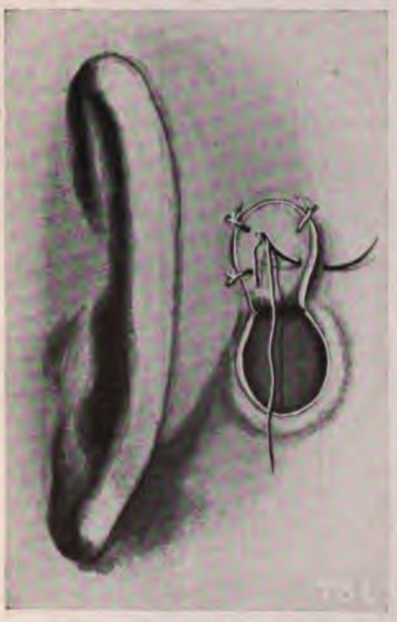


Fig. 400.

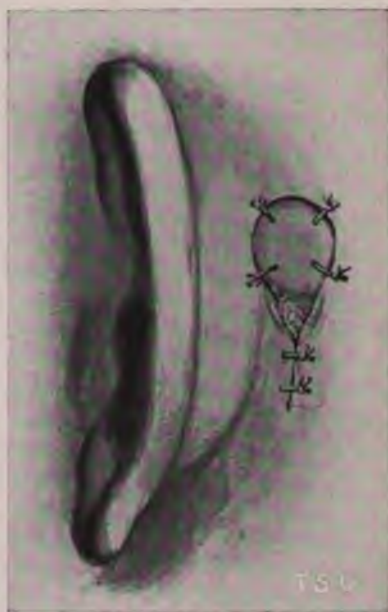


Fig. 401.

The von Mosetig-Moorhoff operation for posterior deficiencies.

It is necessary at times to shape the stump remaining so that the artificial ear may fit and hold properly. Again there may be no external part at all, and then it may be necessary to construct from the

Fig. 402.

Fig. 403.

Goldstein's retro-auricular plastic.

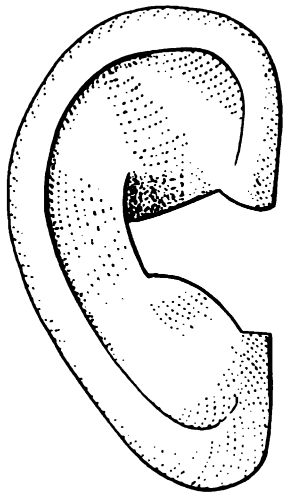


Fig. 404.

Celluloid artificial ear.

tissues surrounding the area of the auditory meatus a place for the attachment of the prothesis. Fig. 404 illustrates a celluloid artificial ear.

Neuroplasty for Facial Paralysis.

The various plastic operations on the facial nerve are performed for the purpose of reëstablishing the function of the peripheral branches of the facial nerve after it has left the stylomastoid foramen, by transplanting this distal end into another motor nerve or approximating it directly to the central or proximal portion of such a nerve. All branches of the facial nerve given off within the temporal bone are not influenced by anastomosing procedures. The direct repair of the severed facial nerve is not considered in this discussion of neuroplasty. The methods employed heretofore are:

1. Facial-spinal accessory end to end anastomosis.

2. Facial-hypoglossal, end (facial nerve) to side (of hyperglossal).

3. Facial-hypoglossal, end to end.

4. Facial-spinal accessory and descendens hypoglossi-spinal accessory anastomosis.

5. Facial-glossopharyngeal anastomosis.

The principles underlying neuroplastic surgery are:

1. The approximating nerves must be under absolutely no tension.

2. The neural structures of one nerve should be in contact with the neural structures of the opposite nerve. (This is particularly necessary in the end to side methods.)

3. Suturing must be done with the finest of material and under great care (not so many sutures being used as to endanger strangulation).

4. The anastomosed nerves should be surrounded with muscle tissue or Cargile membrane, to prevent too great a cicatricial formation about them.

5. Absolute asepsis is necessary to obtain a good result.

6. Adjunct treatment such as electricity, massage, tonics, etc., following the operation hastens recovery, the time depending on the degree of muscular atrophy which preceded the operation.

7. Correct diagnosis before the operation as to the reaction to degeneration is very important, so as to be sure that if a perfect anastomosis operation is performed and union is absolutely perfect, a good result is possible; otherwise this excellent therapeutic procedure would be discredited, as the muscle would not be susceptible of motion in spite of the unimpeded nerve stimulus.

Spino-Facial and Periphero-Spinal to Descendens Hypoglossi Anastomosis.*

1. Make a Y-shaped incision, one branch of the Y ending in front of the tragus, the other back of the ear on the line with the tragus. The stalk of the Y is directed forward and downward, in front of the sternomastoid, for about three inches in length. This incision goes through skin and superficial fascia. (Fig. 405.)

2. Dissect bluntly down to the muscles and expose the posterior border of the parotid gland.

3. Elevate the lobule of the ear, draw forward the parotid gland and dissect down into the narrow space between the anterior border

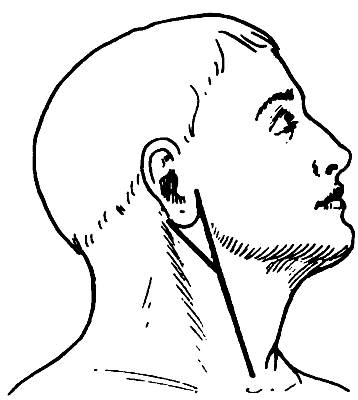


Fig. 405.
Incision for spino-facial anastomosis.

of the mastoid and the posterior border of the ramus of the lower jaw. Here locate the facial nerve in its course from the stylomastoid foramen towards the posterior border and the under surface of the parotid gland.

4. Place a ligature (but not tied) around it for subsequent identification and leave this field of operation for the time being for the location of the other nerves. (Fig. 406.)

5. Find the spinal accessory nerve, which is on the line from the angle of the lower jaw backward, where it pierces the fascia of the sternomastoid muscles.

6. Place a suture about it for the same purpose as in the facial. (Fig. 406.)

*Contributed by W. W. Grant, M.D., Denver.

7. Expose the hypoglossal which lies in this region, just where the occipital artery is given off from the external carotid, about the central tendon of the digastric muscle.

8. Cut the digastric muscle posterior to its central tendon and reflect this posterior belly backward.

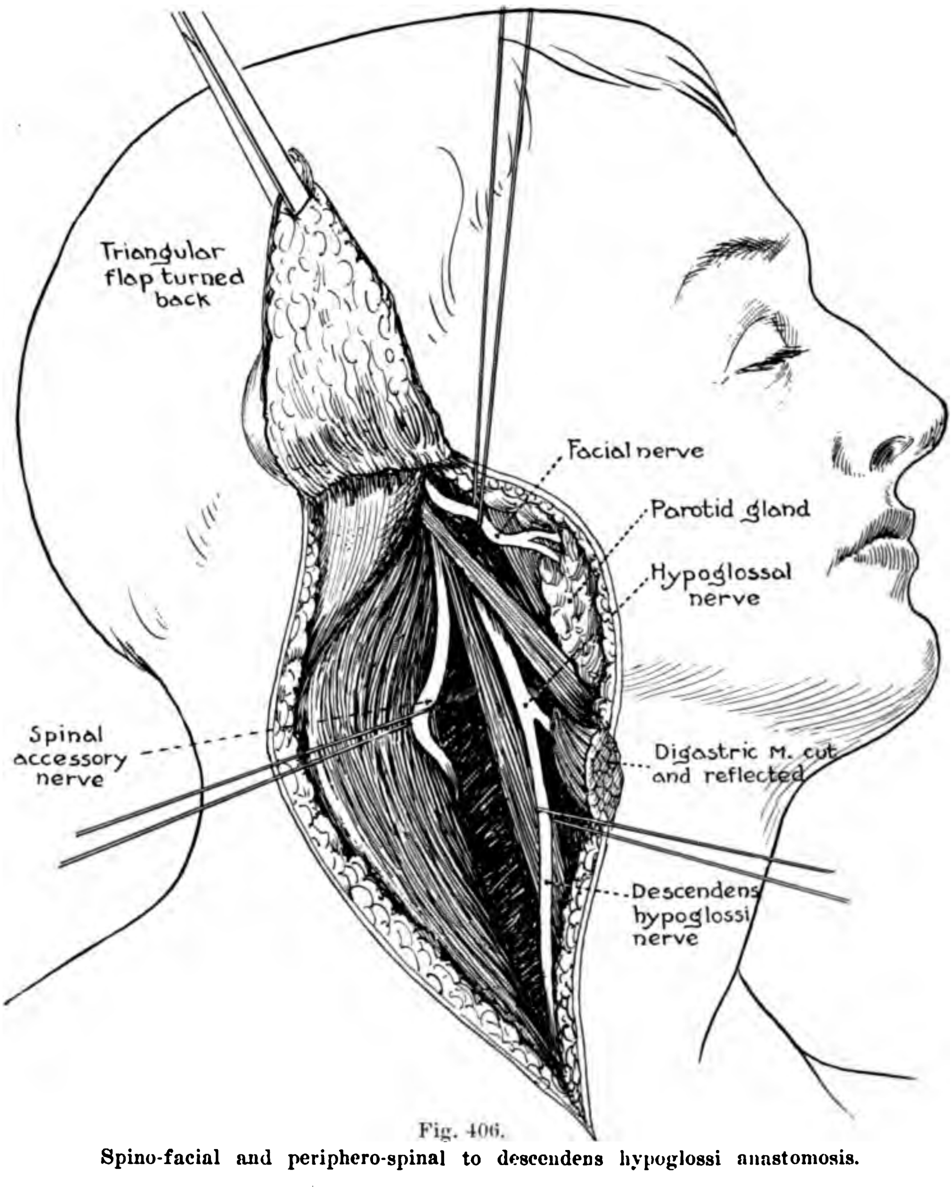


Fig. 406.
Spino-facial and periphero-spinal to descendens hypoglossi anastomosis.

9. Locate the descendens hypoglossi at this point as it leaves the hypoglossal and passes downward on the sheath of the common carotid artery. Place a thread about this nerve also. (Fig. 406.)

10. Go back to the facial nerve, draw it out so as to be able to reach the end that comes from the stylomastoid foramen and with a pair of slender scissors sever it close to this foramen and pull out this end of the nerve.

11. Pull on the spinal accessory and sever it just before it enters the sternomastoid muscle, making sure before it is severed that a long enough segment may be drawn to unite with the facial stump without occasioning any tension when their ends are united.

12. Have an assistant hold both ends. Then cut off the spinal accessory and the peripheral end of the facial in close and exact approximation, the operator suturing them with fine linen thread, and using a small round needle. One suture is to be made at each side,

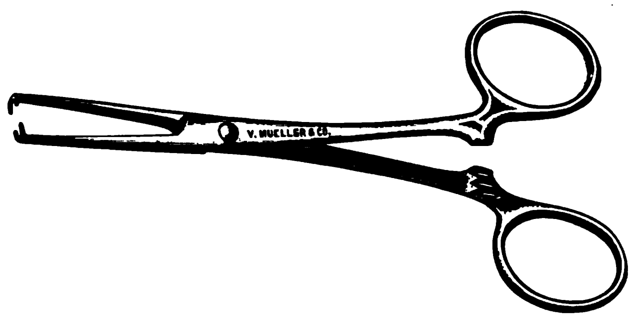


Fig. 407.
Beck's nerve tracing forceps.

possibly including some nerve fibres, and another supporting suture through the neurilemma only on the under surface. The sutures are tied only moderately tight.

13. To prevent cicatricial constriction, place some Cargile membrane at the point of nerve union about this anastomosis.

14. Now sever the descendens hypoglossi by drawing on the thread fully three-fourths of an inch below where it leaves the hypoglossal, and turn this cut end upward.

15. Approximate this end of the descendens hypoglossi and the peripheral end of the spinal accessory with the same technic as was used on the facial nerve.

16. Reunite the digastric muscle and close the wound without drainage.

Facial-Spinal Accessory Anastomosis.

1. Make an incision through the skin facia from behind the ear forward and downward along the anterior border of sternomastoid muscle, to about the level of the thyroid cartilage.

2. Retract and find the spinal accessory nerve as it pierces the sternomastoid muscle.

3. Dissect and retract forward over the lower jaw, exposing the parotid gland (posterior border).

4. Locate the facial nerve as it enters this gland.

5. Follow it below the cartilaginous portion of the external auditory canal down between the posterior border of the ramus of the lower jaw and the anterior border of the mastoid process.

6. It may be necessary to divide the posterior belly of the digastric muscle. Retract the stylohyoid muscle and pass about the nerve the author's nerve tracing forceps. (Fig. 407.) Follow the nerve to the stylomastoid foramen, which is behind the styloid process, and close on the nerve.

7. Steadily pull the nerve out of the mastoid canal (stylomastoid foramen) and keep the forceps attached to the nerve.

8. Withdraw as much of the spinal accessory nerve as is necessary to make an easy approximation with the dissected facial nerve.

9. Trim the facial nerve end squarely to fit the spinal accessory and suture the two end to end.

10. Three sutures are placed, going through the neurilemma and taking in a few of the axis cylinders. An additional supporting suture (continuous) takes in only the sheath of both the nerves.

11. Make a slit or pocket into the posterior belly of the digastric muscle (if it is divided it should first be united), or place a layer of Cargile membrane about the anastomosis.

12. Close wound.

Facial-Hypoglossal End to Side Anastomosis.

1. Incise the skin, fascia and platysma, beginning behind the ear and carrying the cut downward and then forward towards the thyroid cartilage.

2. Retracing the tissues, the hypoglossal nerve is located by drawing up the digastric muscles posterior to the sternomastoid where the sheaths of the great vessels lie. On the level of the thyroid cartilage, where the carotid artery divides into the external and internal branches, the hypoglossal nerve will be seen at the point of crossing of the occipital and the internal carotid arteries. Here it turns forward and lies on the mylohyoid muscle.

3. Expose the hypoglossal nerve at the point closest to the facial nerve.

4. Locate the facial nerve as in the facial-spinal accessory anastomosis, and draw it out in the manner described above from the stylomastoid foramen.

5. Trim the facial stump in such a manner as to strip the majority of the axis cylinders of their sheaths for about three lines.

6. Place three sutures through the stump, thus getting it ready to join with the hypoglossal nerve.

7. Make a small buttonhole in the exposed hypoglossal nerve at the point mentioned in division 3, parallel to the course of the nerve and on its upper border, to admit the prepared facial stump. It is

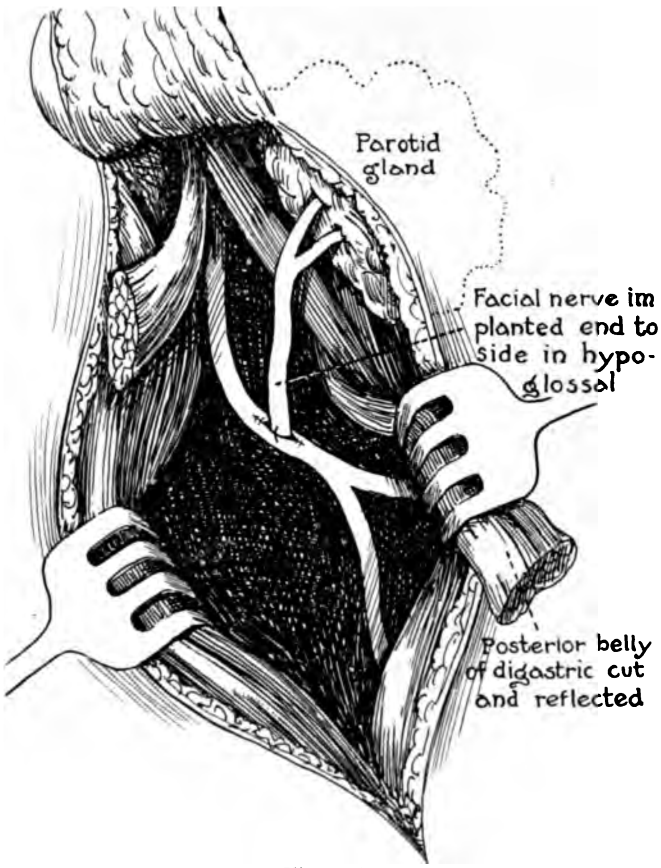


Fig. 408.
Facial-hypoglossal end to side anastomosis.

well to enter this buttonhole slit with a fine pair of scissors and cut a few axis cylinders transversely within the sheath in order to get direct contact with the facial axis cylinders and thus obtain a more rapid regeneration.

8. Pass the already prepared sutures of the facial stump through the slit in the hypoglossal nerve from within, outward, one on each side and the third at one end. The tying should be done by the oper-

ator while the assistant keeps the slit open with a fine pair of forceps (spring) and holds the facial stump steady in the slit. Another supporting suture surrounds this anastomosis in the same manner as in the spinal accessory procedure. (Fig. 408.)

9. The same procedure as in the facial spinal accessory is followed in the prevention of cicatricial formation about the union, as is also in the closure of the external wound.

Facial-Hypoglossal End to End Anastomosis.

1. The same procedure as in the end to side operation up to the

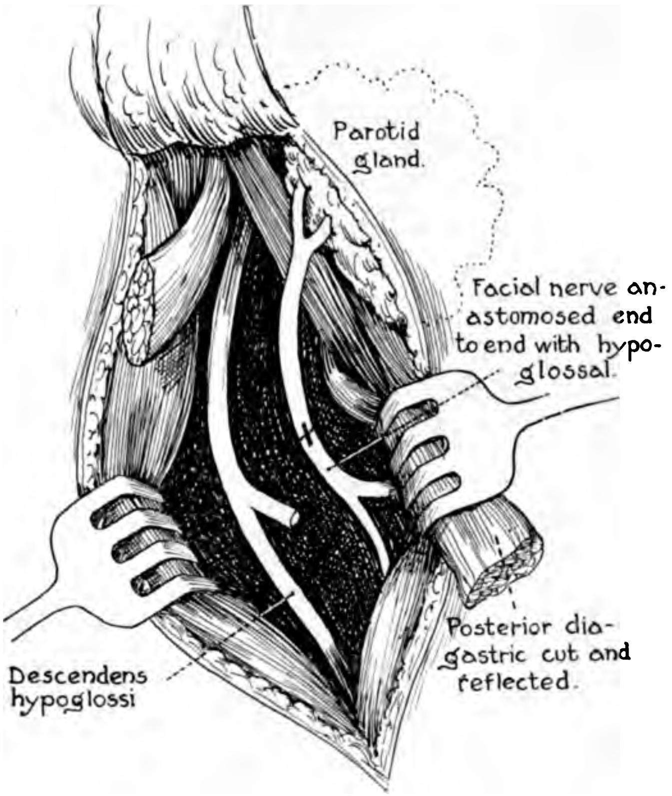


Fig. 409.
Facial-hypoglossal end to end anastomosis.

point of union, except that the hypoglossal is not prepared so close to the facial nerve. (Fig. 409.)

2. Follow the hypoglossal nerve nearer to the front as it enters the floor of the mouth.

3. Sever the hypoglossal and turn it back to join it with the facial nerve, which has also been prepared as in the other two previous procedures.

4. The union and management of the anastomosis and the wound are subject to the same procedure as in the facial-spinal accessory operation.

Myeloplasty for Facial Paralysis.

In cases of congenital facial paralysis, or in permanent paralysis in which the peripheral branches of the facial nerve are imbedded in cicatricial connective tissue, or when the paralyzed muscles of the face supplied by the seventh cranial nerve are completely atrophied and do not react to the electric currents, or finally if for any reason the hypoglossal or accessory nerves are not accessible and the neuroplastic operation cannot be performed for any other reason, the masseter muscles may be used to obtain a straighter face. The associated movements following this operation are objectional. These, however, do not persist, for the patients re-educate that particular part of the masseter muscle which causes facial expressions.

Technic.—Under local or general anesthesia make an incision along the posterior border of the ramus of the lower jaw. The tissues are dissected forward until part of the masseter muscles is reached. These are now separated from their attachment to the ramus of the jaw and the lower border. A sort of a tunnel is now made with a pair of Mayo's scissors, spreading the tissues rather than cutting them, until one reaches the external angle of the mouth. It is important not to go too high in order not to wound the duct of the parotid gland. As the angle of the mouth is approached, care must be taken not to wound the facial artery. The facial vein must sometimes be ligated. Great care is to be exercised not to penetrate through the mucous membrane of the mouth or the skin externally. The masseter muscles already severed are now armed on two silkworm gut sutures, with very short curved needles, one on each end of the thread so as to have four needles in all. One thread is now passed close to the upper lip, through the subcutaneous tissue and skin, while the second thread is placed close to the lower lip. These sutures are tied over a piece of gauze to prevent their cutting in. The wound is closed completely without drainage.

During the next three weeks the patient takes only liquid diet in order not to use the masseter muscles. The stitches holding them are removed at the end of ten days, as are also those of the incision.